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UNIVERSITY OF PITTSBURGH, PITTSBURGH, PA.

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## OUR CONVENTION

By O. J. FERGUSON, President

The Society for the Promotion of Engineering Education is well started on its way toward setting up a statement of principles of thought and of action that may be considered epochal.

I have just returned from a meeting of the special committee on Aims and Scope of Engineering Curricula, held in Chicago. This was the fourth or fifth meeting held, at which a considerable group of members conferred upon this highly important subject. Repeatedly, they have worked over and over paragraphs, sentences, phrases, and even words, to build up a consistent, clear-cut, truth-telling statement which we may all be able to accept. It is with profound respect that I observe the deliberations of this committee, because at no time does there ever appear anything but the most insistent demand for clarity of statement of proved facts and accepted beliefs, and of honest and high purpose.

When their immediate task is finished, we shall receive from them something that will give further impetus to the work of our Society and of our colleges of engineering.

The theme of the Annual Convention to be held in Berkeley June 24–28 is "The Unfolding Obligations of Engineering Education." It was chosen without foreknowledge of the trends of the deliberations of the Committee on Aims and Scope. Yet, because the minds of our members seem to be keyed to the thought of responsibilities and opportunities, and because we are keenly alert to the changing conditions under which we must continue to operate, this central thought closely parallels the idea to which the above committee addressed itself.

The committee report will probably not await the convention, but will be given to you as soon as practicable. It is to be expected that its utterances will need study and careful weighing. There must be opportunity for discussion and understanding. It is to be expected that the time will be ripe for this, at the convention.

As to the annual meeting, the program is developing well and promisingly. There is being set up a large number of conferences of sections. Four general sessions are planned, one of which will project the convention theme; one will address itself to those phase of youth development which come through non-curricular influences; a third probably will deal with certain curricular ele-

ments; the fourth will be a forenoon session of institutional delegates.

Our hosts have their plans for our accommodation exceptionally well advanced, and we can see even this early that the five-day convention period will be gone much too quickly. Prepare for delightful participation in a fruitful session!

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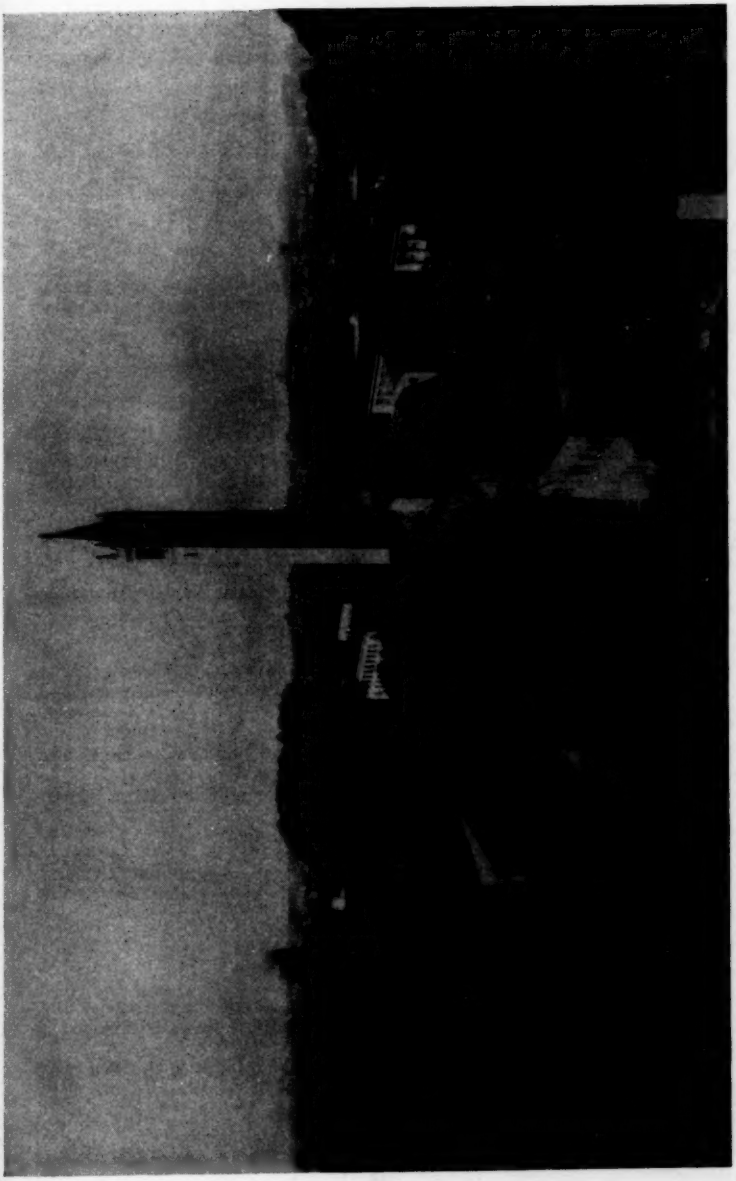
## TO CALIFORNIA IN JUNE

June 24 to 28, 1940, will find the members of the Society for the Promotion of Engineering Education in convention on the Berkeley Campus of the University of California.

Hosts of the convention extend a hearty invitation to all members to attend this 48th annual meeting. The theme of the convention is "Unfolding Obligations in Engineering Education." A program of unusual significance is in preparation. There will be opportunity for eastern and western members to mingle at this Pacific Coast meeting to a greater degree than for some years past. The Junior College movement, well advanced in California, will be discussed. Opportunities to meet junior college administrators and to inspect facilities of some of these institutions will be provided. Interesting and instructive trips in the San Francisco Bay area will be arranged. Stanford University is but forty miles from the Berkeley Campus and plans are being made for one full day's session at Stanford. The great bridges of San Francisco Bay may be seen from the Sather tower and other points of University buildings.

Those who desire to drive to the Convention may visit national parks and other significant points of interest along the way. Recreation and vacation can well be combined with the inspiration and instruction of the convention.

The local chairman for the meeting is Professor B. M. Woods, University of California, Berkeley. Inquiries may be addressed to him or to the Secretary of the Society.



UNIVERSITY OF CALIFORNIA—VIEW OF SATHER TOWER AND CENTRAL PORTION OF BERKELEY CAMPUS

## TENTATIVE ITINERARY TO 1940 MEETING

The proposed itinerary, over the Union Pacific Railroad, is as follows:

Lv. Chicago 4:00 P.M. Wednesday, June 19
Ar. Denver 8:20 A.M. Thursday, June 20

Morning bus excursion to Denver mountain parks, including the summit of Lookout Mountain. Luncheon at the Albany Hotel and a short trip by bus through the civic and residential sections of the city.

Lv. Denver 3:10 P.M.
Ar. Colorado Springs 5:00 P.M. Thursday, June 20

Over night at the Antlers Hotel. Members of the party may take the sunrise trip to Pike's Peak, leaving at 2:00 A.M., or a special party, leaving at 6:00 A.M.

Lv. Colorado Springs 10:40 A.M. Friday, June 21
via Royal Gorge
Ar. Salt Lake City 7:30 A.M. Saturday, June 22

Headquarters at the Utah Hotel. Morning trip by bus through Salt Lake City including a visit to the Mormon Temple and Tabernacle with organ recital. In the afternoon, a trip to the Lake for bathing at Saltair Beach.

Lv. Salt Lake City 11:35 P.M. Saturday, June 22
Ar. Berkeley 8:31 P.M. Sunday, June 23

This train provides a daylight trip through the Sierra Nevada Mountains and along the American River Canyon.

Any one of six return trips may be selected:

1. Via Los Angeles and Boulder Dam. Extra expense, $1.80.
2. Via Santa Fe Railroad with stop at the Grand Canyon. Extra expense, standard, $7.00, tourist, $5.00.
3. Via Pacific Northwest and Columbia River.
4. Via Vancouver and Canadian Pacific, including Banff and Lake Louise. Extra railroad fare, $5.00.
5. Via Northern Pacific Railroad, including Yellowstone Park. Extra railroad fare, $1.25.
6. Via Great Northern Railroad and Glacier National Park.

The following estimates include round-trip rail tickets from Chicago; lower berth, Chicago to Berkeley; sightseeing trips stated above, and meals and hotels, Chicago to Berkeley.

With standard sleeper: $135.85
With tourist sleeper: 115.90

For a party of 18 a special car will be assigned and for a party of 100, a special train will be provided. The return railroad ticket is included in order to take advantage of the Circle Tour rates.

Anyone interested in this trip should communicate with the Secretary of the Society, F. L. Bishop.

## ENGINEERING ENROLLMENTS, 1939–40

153 institutions giving instruction in engineering were requested to furnish the following information. 146 had replied as of December 30, 1939.

| Engineering Courses | Freshmen (1st year) | Sophomores (2nd year) | Juniors (3d year) | Seniors (4th year) | 5th Year (of 5-yr. Curriculum) | Special Students | Evening Students | Others (Please name) ..... | Totals |
|---|---|---|---|---|---|---|---|---|---|
| Aeronautical | 972 | 808 | 599 | 503 | 26 | 2 | 119 | 5 | 3,034 |
| Agricultural | 223 | 296 | 229 | 195 | — | 3 | 5 | — | 951 |
| Architectural | 290 | 247 | 205 | 169 | 2 | 1 | — | — | 914 |
| Ceramic | 152 | 177 | 148 | 134 | — | 44 | — | — | 655 |
| Chemical | 3,972 | 4,188 | 3,316 | 2,955 | 228 | 54 | 543 | 12 | 15,268 |
| Civil | 2,601 | 2,858 | 2,496 | 2,335 | 114 | 48 | 616 | 23 | 11,091 |
| Electrical | 3,759 | 4,044 | 3,526 | 2,906 | 157 | 66 | 1,214 | 8 | 15,680 |
| General | 932 | 605 | 378 | 332 | 31 | 5 | 371 | 2 | 2,656 |
| Industrial | 340 | 579 | 597 | 622 | 34 | 5 | 126 | — | 2,303 |
| Mechanical | 5,987 | 6,866 | 5,345 | 4,245 | 255 | 100 | 1,695 | 398 | 24,891 |
| Metallurgical | 349 | 605 | 505 | 550 | 7 | 5 | 231 | 4 | 2,256 |
| Mining | 526 | 592 | 581 | 552 | 1 | 10 | 7 | — | 2,269 |
| Unclassified | 11,694 | 2,319 | 1,627 | 1,284 | 22 | 115 | 6,697 | 176 | 23,934 |
| Totals | 31,797 | 24,184 | 19,552 | 16,782 | 877 | 458 | 11,624 | 628 | 105,892 |

*Enrollment of Undergraduate Engineering Students, 1939–40*

| Engineering Courses | Freshmen (1st year) | Sophomores (2nd year) | Juniors (3d year) | Seniors (4th year) | 5th Year (of 5-yr. Curriculum) | Special Students | Evening Students | Others | Totals | No. of First Degrees Conferred During the Academic Year 1938–39 |
|---|---|---|---|---|---|---|---|---|---|---|
| Akron Uni. | 3 | 45 | 39 | 33 | 40 | — | — | 1 | 161 | 17 |
| Ala. Poly. | 377 | 270 | 215 | 189 | — | — | — | 7 | 1,058 | 170 |
| Ala. Uni. | 341 | 200 | 142 | 130 | — | 2 | 70 | 8 | 894 | 78 |
| Alaska Uni. | 37 | 21 | 25 | 16 | 2 | 1 | — | — | 102 | 16 |
| Ariz. Uni. | 144 | 114 | 82 | 69 | — | 9 | — | — | 418 | 43 |
| Ark. Uni. | 110 | 116 | 89 | 39 | — | — | — | 1 | 355 | 39 |
| Armour I. T. | 321 | 269 | 196 | 168 | — | 47 | 1,616 | 286 | 2,903 | 119 |
| Brooklyn P. I. | 161 | 146 | 107 | 108 | — | — | 1,404 | — | 1,926 | 117 |
| Brown Uni. | 54 | 46 | 24 | 35 | — | — | — | — | 159 | 35 |
| Bucknell Uni. | 79 | 63 | 46 | 38 | — | — | — | — | 226 | 31 |
| Calif. Uni. | 394 | 387 | 641 | 550 | — | 44 | — | — | 2,016 | 302 |
| Calif. So. Uni. | 74 | 71 | 106 | 105 | — | 8 | 207 | 19 | 590 | — |
| Calif. I. T. | 160 | 81 | 112 | 113 | — | — | — | — | 466 | 85 |
| Carnegie I. T. | 360 | 284 | 228 | 233 | — | 3 | 857 | — | 1,965 | 198 |
| Case Sch. Ap. Sci. | 295 | 232 | 227 | 179 | — | — | 624 | — | 1,557 | — |
| Catholic Uni. | 69 | 52 | 35 | 24 | — | — | — | 8 | 188 | 15 |
| Cincinnati Uni. | 331 | 285 | 254 | 224 | 168 | — | 224 | — | 1,486 | 138 |
| Citadel | 85 | 65 | 29 | 31 | — | — | — | — | 210 | 25 |
| Clarkson Coll. | 152 | 147 | 99 | 68 | — | — | — | — | 466 | 50 |
| Clemson Coll. | 306 | 210 | 148 | 110 | — | — | — | — | 774 | 65 |

*Enrollment of Undergraduate Engineering Students, 1939–40—Continued*

| Engineering Courses | Freshmen (1st year) | Sophomores (2nd year) | Juniors (3d year) | Seniors (4th year) | 5th Year (of 5-yr. Curriculum) | Special Students | Evening Students | Others | Totals | No. of First Degrees Conferred During the Academic Year 1938–39 |
|---|---|---|---|---|---|---|---|---|---|---|
| Colo. St. Coll..... | 91 | 67 | 76 | 48 | — | — | — | — | 282 | 36 |
| Colo. Mines..... | 205 | 221 | 178 | 146 | — | — | — | — | 750 | 131 |
| Colo. Uni..... | 285 | 208 | 183 | 153 | — | 1 | — | — | 830 | 111 |
| Columbia Coll..... | 121 | 102 | 44 | 5 | — | — | — | — | 272 | — |
| Columbia Uni..... | — | — | 126 | 107 | — | 27 | — | — | 213 | 46 |
| Conn. Uni..... | 63 | 46 | 18 | 11 | — | — | — | — | 138 | 6 |
| Cooper U. (Day).. | 113 | 99 | 65 | 59 | — | — | — | — | 336 | 46 |
| Cooper U. (Eve.).. | 247 | 192 | 190 | 161 | 104 | 67 | — | — | 961 | 50 |
| Cornell Uni..... | 439 | 363 | 239 | 186 | 13 | — | — | — | 1,240 | 148 |
| Dartmouth Coll... | — | — | — | 9 | 9 | — | — | — | 18 | — |
| Dayton Uni..... | 71 | 40 | 45 | 26 | — | 2 | 86 | — | 270 | 31 |
| Dela. Uni..... | 87 | 64 | 47 | 29 | — | 3 | — | — | 230 | 25 |
| Denver Uni..... | 28 | 22 | 17 | 28 | — | — | — | — | 95 | — |
| Detroit Uni..... | 281 | 124 | 164 | 83 | 77 | 6 | 47 | — | 782 | 65 |
| Drexel I. T..... | 302 | 188 | 127 | 114 | 103 | 6 | 2,718 | — | 3,558 | 103 |
| Duke Uni..... | 67 | 55 | 35 | 24 | — | 7 | — | 26 | 214 | 26 |
| Fenn Coll..... | 130 | 44 | 21 | 7 | 41 | — | 436 | — | 679 | 54 |
| Florida Uni..... | 140 | 100 | 89 | 95 | — | — | — | — | 424 | 56 |
| Ga. Sch. Tech..... | 722 | 594 | 359 | 219 | 3 | — | — | — | 1,897 | 254 |
| Geo. Wash. U..... | 188 | 53 | 63 | 35 | — | — | — | — | 339 | 28 |
| Gettysburg C.*... | — | — | — | 5 | — | — | — | — | 5 | 4 |

* Engineering College discontinued when seniors graduate.

*Enrollment of Undergraduate Engineering Students, 1939–40—Continued*

| Engineering Courses | Freshmen (1st year) | Sophomores (2nd year) | Juniors (3d year) | Seniors (4th year) | 5th Year (of 5-yr. Curriculum) | Special Students | Evening Students | Others | Totals | No. of First Degrees Conferred During the Academic Year 1938–39 |
|---|---|---|---|---|---|---|---|---|---|---|
| Harvard Uni..... | —— | 37 | 28 | 37 | —— | —— | —— | 12 | 114 | 38 |
| Hawaii Uni..... | 34 | 36 | 14 | 6 | —— | —— | —— | 10 | 100 | 5 |
| Howard Uni..... | 28 | 5 | 5 | 4 | —— | —— | —— | —— | 42 | 2 |
| Idaho Uni..... | 153 | 99 | 78 | 62 | —— | 2 | —— | —— | 394 | 67 |
| Illinois Uni..... | 751 | 535 | 513 | 449 | —— | —— | —— | 101 | 2,349 | 312 |
| Iowa St. Coll..... | 628 | 598 | 352 | 306 | —— | —— | —— | —— | 1,884 | 251 |
| Iowa Uni..... | 143 | 100 | 105 | 81 | —— | 3 | —— | —— | 432 | 70 |
| Johns Hopkins U.. | 75 | 103 | 82 | 68 | —— | —— | 1,251 | —— | 1,579 | 51 |
| Kans. St. Coll..... | 328 | 266 | 228 | 185 | —— | 6 | —— | —— | 1,013 | 157 |
| Kansas Uni..... | 228 | 173 | 139 | 148 | —— | —— | —— | —— | 688 | 113 |
| Kentucky Uni..... | 161 | 140 | 75 | 44 | —— | 1 | —— | —— | 421 | 58 |
| Lafayette Coll..... | 106 | 92 | 70 | 50 | —— | 1 | —— | —— | 319 | —— |
| Lehigh Uni..... | 365 | 298 | 233 | 214 | —— | —— | —— | —— | 1,110 | 194 |
| Lewis Inst..... | 67 | 60 | 40 | 29 | —— | 14 | 329 | —— | 539 | 23 |
| La. S. W. Inst. ... | 110 | 90 | 30 | 14 | —— | —— | —— | —— | 244 | —— |
| La. St. Uni..... | 472 | 183 | 239 | 170 | —— | 4 | 4 | —— | 1,072 | 117 |
| Louisville Uni..... | 115 | 62 | 38 | 39 | —— | —— | 29 | —— | 283 | 34 |
| Maine Uni..... | 202 | 166 | 123 | 99 | —— | 20 | —— | —— | 610 | 66 |
| Manhattan Coll... | 92 | 75 | 61 | 55 | —— | —— | —— | —— | 283 | 36 |

*Enrollment of Undergraduate Engineering Students, 1939–40—Continued*

| Engineering Courses | Freshmen (1st year) | Sophomores (2nd year) | Juniors (3d year) | Seniors (4th year) | 5th Year (of 5-yr. Curriculum) | Special Students | Evening Students | Others | Totals | No. of First Degrees Conferred During the Academic Year 1938–39 |
|---|---|---|---|---|---|---|---|---|---|---|
| Marquette Uni.... | 184 | 96 | 110 | 90 | 87 | 5 | —— | —— | 572 | 68 |
| Maryland Uni..... | 271 | 141 | 69 | 56 | —— | 4 | —— | —— | 541 | 40 |
| Mass. I. T..... | 524 | 472 | 459 | 498 | 4 | —— | —— | —— | 1,957 | 409 |
| Mich. M. & T..... | 253 | 213 | 172 | 154 | —— | —— | —— | —— | 792 | 122 |
| Mich. St. Coll..... | 350 | 255 | 180 | 147 | —— | 1 | —— | —— | 933 | —— |
| Mich. Uni..... | 552 | 557 | 535 | 491 | —— | 16 | —— | —— | 2,151 | —— |
| Minn. Uni..... | 598 | 577 | 467 | 468 | —— | 2 | —— | —— | 2,112 | 316 |
| Miss. St. Coll..... | 224 | 216 | 126 | 146 | —— | —— | —— | —— | 712 | 126 |
| Miss. Uni..... | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— |
| Missouri Mines... | 230 | 213 | 198 | 167 | —— | —— | —— | —— | 808 | 117 |
| Missouri Uni..... | 243 | 148 | 128 | 77 | —— | —— | —— | —— | 596 | 44 |
| Mont. St. Coll..... | 195 | 124 | 78 | 83 | —— | —— | —— | —— | 480 | 48 |
| Mont. Mines..... | 102 | 75 | 67 | 53 | —— | 1 | —— | —— | 298 | 27 |
| Nebr. Uni..... | 303 | 189 | 152 | 100 | 1 | —— | —— | —— | 745 | 105 |
| Nevada Uni..... | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— |
| Newark Coll..... | 251 | 195 | 154 | 117 | —— | —— | 199 | —— | 916 | 150 |
| N. Hamp. Uni..... | 149 | 95 | 81 | 62 | —— | 7 | —— | —— | 394 | 55 |
| N. Mex. Uni..... | 105 | 47 | 40 | 30 | —— | 4 | —— | —— | 226 | —— |
| N. Mex. A. M..... | 70 | 65 | 40 | 26 | —— | —— | —— | —— | 201 | 20 |
| N. Mex. Mines.... | 158 | —— | —— | —— | —— | —— | —— | —— | 158 | —— |
| N.Y. Coll. Ceramics | 65 | 60 | 54 | 39 | —— | 2 | —— | —— | 220 | —— |
| N. Y. Coll. City... | 528 | 329 | 243 | 280 | 33 | —— | —— | —— | 1,413 | 396 |
| New York Uni.... | 278 | 281 | 190 | 154 | —— | 4 | 1,101 | 61 | 2,069 | 211 |

*Enrollment of Undergraduate Engineering Students, 1939–40—Continued*

| Engineering Courses | Freshmen (1st year) | Sophomores (2nd year) | Juniors (3d year) | Seniors (4th year) | 5th Year (of 5-yr. Curriculum) | Special Students | Evening Students | Others | Totals | No. of First Degrees Conferred During the Academic Year 1938–39 |
|---|---|---|---|---|---|---|---|---|---|---|
| No. Car. St. Coll. | 519 | 286 | 214 | 160 | — | 1 | 5 | — | 1,185 | 134 |
| No. Dak. Coll. | 118 | 66 | 72 | 57 | — | — | — | — | 313 | — |
| No. Dak. Uni. | 126 | 55 | 43 | 31 | 1 | 41 | — | — | 126 | 34 |
| Northeastern U. | 413 | 382 | 271 | 216 | 142 | — | — | — | 1,424 | 149 |
| Northwestern U. | 107 | 59 | 54 | 48 | — | 1 | — | — | 269 | 30 |
| Norwich Uni. | 54 | 35 | 26 | 26 | — | — | — | — | 141 | 18 |
| Notre Dame U. | 194 | 125 | 99 | 75 | — | 2 | — | — | 495 | 70 |
| Ohio St. Uni. | 571 | 491 | 362 | 351 | 1 | — | — | — | 1,776 | 258 |
| Ohio Uni. | 70 | 26 | 28 | 32 | — | — | — | — | 156 | 31 |
| Ohio No. U. | 43 | 46 | 35 | 26 | — | — | — | — | 150 | 16 |
| Okla. A. M. | 487 | 299 | 224 | 231 | — | 5 | — | — | 1,246 | 129 |
| Okla. Uni. | 425 | 345 | 433 | 389 | — | — | — | — | 1,592 | 172 |
| Ore. St. Coll. | 334 | 227 | 148 | 151 | — | — | — | — | 860 | 93 |
| Pa. St. Coll. | 475 | 443 | 334 | 358 | — | 4 | — | — | 1,614 | 283 |
| Pa. Uni. Towne | 101 | 98 | 78 | 66 | — | — | — | — | 343 | 57 |
| Moore Sc. E. E. | 20 | 17 | 29 | 18 | — | — | — | — | 84 | 15 |
| Pittsburgh Uni. | 244 | 227 | 195 | 195 | — | 12 | 201 | 60 | 1,134 | 165 |
| Puerto Rico Uni. | 201 | 164 | 186 | 181 | — | — | — | 31 | 763 | 120 |
| Princeton Uni. | 141 | 106 | 69 | 63 | — | — | — | — | 379 | — |
| Purdue Uni. | 1,224 | 957 | 829 | 667 | — | 4 | — | — | 3,681 | 531 |
| Rensselaer | 354 | 338 | 285 | 222 | — | 4 | — | — | 1,203 | 156 |

*Enrollment of Undergraduate Engineering Students, 1939–40—Continued*

| Engineering Courses | Freshmen (1st year) | Sophomores (2nd year) | Juniors (3d year) | Seniors (4th year) | 5th Year (of 5-yr. Curriculum) | Special Students | Evening Students | Others | Totals | No. of First Degrees Conferred During the Academic Year 1938–39 |
|---|---|---|---|---|---|---|---|---|---|---|
| R. I. St. Coll..... | 117 | 83 | 72 | 52 | — | — | — | 1 | 325 | 48 |
| Rice Inst..... | 172 | 132 | 101 | 85 | — | — | — | — | 490 | 55 |
| Rochester Uni..... | 54 | 40 | 38 | 16 | — | — | — | — | 148 | 35 |
| Rose Poly..... | 97 | 77 | 51 | 35 | — | — | — | — | 260 | 27 |
| Rutgers Uni..... | 83 | 59 | 52 | 30 | — | 9 | — | — | 233 | 23 |
| Santa Clara U..... | 36 | 31 | 18 | 9 | — | — | — | — | 94 | 11 |
| So. Car. Uni..... | — | — | — | — | — | — | — | — | — | — |
| So. Dak. Coll..... | — | — | — | — | — | — | — | — | — | — |
| So. Dak. Mines... | 152 | 76 | 56 | 72 | — | — | — | — | 356 | 44 |
| So. Meth. Uni..... | 69 | 33 | 34 | 20 | 10 | — | — | — | 166 | 15 |
| Stanford Uni..... | 83 | 106 | 83 | 95 | — | — | — | — | 367 | 74 |
| Stevens I. T..... | 219 | 148 | 132 | 102 | — | 2 | — | — | 603 | 91 |
| Swarthmore Coll... | 27 | 16 | 13 | 14 | — | — | — | — | 70 | 12 |
| Syracuse Uni..... | 144 | 110 | 92 | 83 | — | 3 | 10 | — | 442 | 68 |
| Tenn. Poly..... | — | — | — | — | — | — | — | — | — | — |
| Tenn. Uni..... | 260 | 204 | 122 | 95 | — | 4 | — | — | 685 | — |
| Texas A. M..... | 1,140 | 803 | 495 | 378 | 3 | 4 | — | — | 2,823 | 220 |
| Texas Uni..... | 414 | 431 | 364 | 288 | — | — | — | — | 1,497 | 197 |
| Texas Tech..... | 352 | 211 | 126 | 120 | — | — | — | — | 809 | 52 |
| Texas A. I..... | 96 | 58 | 46 | 25 | — | — | — | — | 225 | 20 |
| Toledo Uni..... | 144 | 79 | 56 | 43 | — | — | 170 | 2 | 494 | 31 |
| Tufts Coll..... | 115 | 95 | 86 | 91 | — | — | — | — | 387 | 73 |

*Enrollment of Undergraduate Engineering Students, 1939–40—Continued*

| Engineering Courses | Freshmen (1st year) | Sophomores (2nd year) | Juniors (3d year) | Seniors (4th year) | 5th Year (of 5-yr. Curriculum) | Special Students | Evening Students | Others | Totals | No. of First Degrees Conferred During the Academic Year 1938–39 |
|---|---|---|---|---|---|---|---|---|---|---|
| Tulane Uni. | 150 | 93 | 63 | 40 | — | — | — | — | 346 | — |
| Tulsa Uni. | — | — | — | — | — | — | — | — | — | — |
| Union Coll. | 57 | 48 | 38 | 23 | — | — | — | — | 166 | 20 |
| Utah Uni. | 167 | 139 | 111 | 68 | — | — | — | — | 485 | 56 |
| Utah Ag. Coll. | 68 | 34 | 45 | 26 | — | — | — | — | 173 | — |
| Valparaiso U. | 27 | 15 | — | 11 | — | — | — | — | 53 | — |
| Vanderbilt U. | 70 | 65 | 44 | 41 | — | — | — | — | 220 | 29 |
| Vermont Uni. | 52 | 32 | 29 | 19 | — | 4 | — | — | 136 | 19 |
| Villanova Coll. | 90 | 60 | 43 | 39 | — | — | — | — | 232 | 21 |
| Va. Mil. Inst. | 105 | 93 | 77 | 68 | — | — | — | — | 343 | 80 |
| Va. Poly. | 646 | 434 | 290 | 254 | — | — | — | — | 1,624 | 189 |
| Va. Uni. | 93 | 63 | 45 | 34 | 3 | — | — | — | 238 | 35 |
| Wash. U. St. Louis | 155 | 86 | 93 | 52 | — | 5 | — | — | 391 | 62 |
| Wash. Uni. | 628 | 244 | 264 | 258 | — | — | — | — | 1,394 | 164 |
| Wash. Coll. | 209 | 175 | 140 | 127 | — | — | — | — | 651 | 76 |
| Wayne Uni. | 233 | 164 | 129 | 98 | — | 7 | 36 | — | 667 | — |
| Webb Inst. | 16 | 18 | 15 | 16 | — | — | — | — | 65 | 13 |
| W. Va. Uni. | 178 | 162 | 99 | 97 | — | 1 | — | — | 537 | 59 |
| Wisconsin Uni. | 457 | 360 | 330 | 300 | — | — | — | — | 1,447 | 202 |
| Worcester P. I. | 188 | 181 | 134 | 103 | — | — | — | — | 606 | 37 |
| Wyoming Uni. | 148 | 85 | 57 | 61 | — | 3 | — | — | 354 | 64 |

*Enrollment of Undergraduate Engineering Students, 1939–40—Continued*

*Enrollment of Undergraduate Engineering Students, 1939–40—Continued*

| Engineering Courses | Freshmen (1st year) | Sophomores (2nd year) | Juniors (3d year) | Seniors (4th year) | 5th Year (of 5-yr. Curriculum) | Special Students | Evening Students | Others | Totals | No. of First Degrees Conferred During the Academic Year 1938–39 |
|---|---|---|---|---|---|---|---|---|---|---|
| Yale Uni..... | —— | 116 | 63 | 75 | —— | 1 | —— | —— | 255 | —— |
| U. S. Schools Totals..... | 30,787 | 23,378 | 18,936 | 16,235 | 845 | 446 | 11,624 | 628 | 102,879 | 12,408 |
| Canadian Schools | | | | | | | | | | |
| Alberta Uni..... | —— | —— | —— | —— | —— | —— | —— | —— | —— | —— |
| Ecole Poly..... | 109 | 73 | 44 | 32 | 31 | 2 | —— | —— | 291 | —— |
| McGill Uni..... | 138 | 136 | 94 | 92 | —— | —— | —— | —— | 460 | 72 |
| New Brunswick U. | 57 | 57 | 43 | 22 | —— | —— | —— | —— | 179 | 21 |
| Queen's Uni..... | 189 | 161 | 143 | 140 | —— | —— | —— | —— | 633 | 125 |
| Toronto Uni..... | 330 | 235 | 197 | 195 | 1 | —— | —— | —— | 958 | 157 |
| Sask. Uni..... | 187 | 144 | 95 | 66 | —— | —— | —— | —— | 492 | 29 |
| Canadian..... | 1,010 | 806 | 616 | 547 | 32 | 2 | —— | —— | 3,013 | 404 |
| United States..... | 30,787 | 23,378 | 18,936 | 16,235 | 845 | 446 | 11,624 | 628 | 102,879 | 12,408 |
| Totals..... | 31,797 | 24,184 | 19,552 | 16,782 | 877 | 458 | 11,624 | 628 | 105,892 | 12,812 |

*Editor's Note:*

146 institutions reported enrollment for 1939–40 compared with 122 for 1938–39; consequently, the totals for this year are very much larger. However, a comparison can be obtained by considering the totals reported by those institutions which have reported each year for the past three years:

1937–38..... 73,945 1938–39..... 79,403 1939–40..... 87,284

This would indicate an increase of approximately 10 per cent this year over last year.

*Enrollment of Graduate Engineering Students, 1939–40*

| Institutions | Enrollment in Work for the Master's Degree | | | | | | Enrollment in Work for the Doctor's Degree | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Full-Time Resident Students | Part-Time Resident Students | Evening Students | Others | Total | Masters Degrees Conferred in 1938–39 | Full-Time Resident Students | Part-Time Resident Students | Evening Students | Others | Total | Doctors Degrees Conferred in 1938–39 |
| Ala. Uni. | 5 | 1 | — | — | 6 | 8 | — | — | — | — | — | — |
| Ala. Poly. | 13 | 15 | — | — | 28 | 6 | — | — | — | — | — | — |
| Ariz. Uni. | 4 | 3 | — | — | 7 | — | — | — | — | — | — | — |
| Armour I. T. | 9 | 34 | 307 | — | 350 | 14 | 8 | 2 | — | — | 10 | 1 |
| Brooklyn P. I. | — | — | 228 | 46 | 274 | 18 | — | — | 20 | — | 20 | — |
| Brown Uni. | — | 1 | — | — | 1 | — | — | — | — | — | — | — |
| Bucknell Uni. | 0 | 2 | 0 | — | 2 | 0 | — | — | — | — | — | — |
| Calif. I. T. | 58 | — | — | — | 58 | 58 | 17 | — | — | 12 | 29 | 8 |
| Calif. Uni. | 108 | — | — | — | 108 | 37 | 4 | — | — | 2 | 6 | 2 |
| Calif. So. Uni. | 383 | 8 | 207 | — | 598 | 9 | — | — | — | — | — | — |
| Carnegie I. T. | 23 | 2 | 102 | — | 127 | 10 | 3 | 1 | — | — | 4 | 1 |
| Case School | 9 | 35 | 37 | — | 81 | 30 | — | 7 | 4 | — | 11 | 1 |
| Catholic Uni. | — | 8 | — | — | 8 | 1 | — | — | — | — | — | — |
| Colo. Mines | 12 | — | — | — | 12 | 6 | 2 | — | — | — | 2 | — |
| Colo. Uni. | 88 | — | — | — | 88 | 21 | — | — | — | — | — | — |
| Columbia Uni. | 58 | 28 | — | — | 86 | 61 | 45 | 42 | — | — | 87 | 4 |
| Cornell Uni. | 38 | 8 | — | 1 | 47 | 27 | 16 | 11 | — | — | 27 | 5 |
| Del. Uni. | 1 | 2 | — | — | 3 | 0 | — | — | — | — | — | — |
| Fla. Uni. | 1 | 5 | — | — | 6 | 1 | — | — | — | — | — | — |
| Ga. Sch. Tech. | — | 27 | — | — | 27 | 6 | — | — | — | — | — | — |

*Enrollment of Graduate Engineering Students, 1939–40—Continued*

| Institutions | Enrollment in Work for the Master's Degree | | | | | | Enrollment in Work for the Doctor's Degree | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Full-Time Resident Students | Part-Time Resident Students | Evening Students | Others | Total | Masters Degrees Conferred in 1938–39 | Full-Time Resident Students | Part-Time Resident Students | Evening Students | Others | Total | Doctors Degrees Conferred in 1938–39 |
| Harvard Uni. | 113 | 14 | — | — | 127 | 92 | 10 | 15 | — | 3 | 28 | 8 |
| Idaho Uni. | 7 | — | — | — | 7 | 9 | — | — | — | — | — | — |
| Illinois Uni. | — | — | — | 61 | 61 | 30 | — | — | — | 19 | 19 | 4 |
| Iowa St. Coll. | 42 | — | — | — | 42 | 19 | — | — | — | — | — | — |
| Iowa Uni. | 43 | 14 | — | — | 57 | 22 | 7 | — | — | — | 7 | 2 |
| John Hopkins U. | 6 | 23 | — | — | 29 | 1 | 22 | — | — | — | 22 | 1 |
| Kans. St. Coll. | 2 | 19 | — | 2 | 23 | 9 | — | — | — | — | — | — |
| Kans. Uni. | 3 | 7 | — | — | 10 | 2 | — | — | — | — | — | — |
| Ky. Uni. | 4 | 2 | — | — | 6 | 1 | — | — | — | — | — | — |
| Lafayette Coll. | 1 | — | — | — | 1 | — | — | — | — | — | — | — |
| Lehigh Uni. | 17 | 43 | — | — | 60 | 30 | 2 | 15 | — | — | 17 | 2 |
| La. Uni. | 24 | — | — | — | 24 | 10 | — | — | — | — | — | — |
| Louisville Uni. | 9 | — | 9 | — | 18 | 4 | — | — | — | — | — | — |
| Maine Uni. | 20 | — | — | — | 20 | 3 | — | — | — | — | — | — |
| Md. Uni. | 1 | — | — | — | 1 | — | 4 | — | — | — | 4 | — |
| M. I. T. | 354 | — | — | — | 354 | 208 | 115 | — | — | — | 115 | 22 |
| Mich. Mines | 4 | — | — | — | 4 | — | — | — | — | — | — | — |
| Mich. St. Coll. | — | 14 | — | — | 14 | 6 | — | — | — | — | — | — |
| Minn. Uni. | 94 | — | — | — | 94 | 25 | 35 | — | — | — | 35 | — |
| Miss. St. Coll. | — | 3 | — | — | 3 | 1 | — | — | — | — | — | — |
| Mo. Mines | 10 | — | — | — | 10 | 3 | 3 | — | — | — | 3 | 0 |

*Enrollment of Graduate Engineering Students, 1939–40—Continued*

| Institutions | Enrollment in Work for the Master's Degree | | | | | | Enrollment in Work for the Doctor's Degree | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Full-Time Resident Students | Part-Time Resident Students | Evening Students | Others | Total | Masters Degrees Conferred in 1938–39 | Full-Time Resident Students | Part-Time Resident Students | Evening Students | Others | Total | Doctors Degrees Conferred in 1938–39 |
| Mo. Uni. | 4 | 14 | — | — | 18 | 1 | — | — | — | — | — | — |
| Mont. Mines | 10 | — | — | — | 10 | 8 | — | — | — | — | — | — |
| Mont. St. Coll. | — | 1 | — | — | 1 | 1 | — | — | — | — | — | — |
| Nebr. Uni. | 11 | — | — | — | 11 | 5 | — | 1 | — | — | 1 | 1 |
| Newark Coll. | — | — | 29 | — | 29 | — | — | — | — | — | — | — |
| N. H. Uni. | — | 3 | — | — | 3 | 6 | — | — | — | — | — | — |
| N. Y. Uni. | 22 | 7 | 224 | — | 253 | 21 | 1 | 6 | 10 | — | 17 | — |
| N. C. St. Coll. | 28 | — | — | — | 28 | 12 | — | — | — | — | — | — |
| Northwestern | — | 3 | 43 | — | 46 | 1 | — | — | — | — | — | — |
| N. D. Uni. | 2 | — | — | — | 2 | 5 | — | — | — | — | — | — |
| Notre Dame | 1 | — | — | — | 1 | 1 | 1 | — | — | — | 1 | — |
| Ohio St. Uni. | 39 | 12 | — | 3 | 54 | 49 | 20 | 8 | — | 8 | 36 | 7 |
| Ohio Uni. | — | 1 | — | — | 1 | 1 | — | — | — | — | — | — |
| Okla. Uni. | 7 | 3 | — | — | 10 | 4 | — | — | — | — | — | — |
| Okla. A. & M. | 31 | — | — | — | 31 | 15 | — | — | — | — | — | — |
| Ore. St. Coll. | 8 | — | — | — | 8 | 5 | — | — | — | — | — | — |
| Pa. St. Coll. | 11 | 41 | — | — | 52 | 28 | 2 | 15 | — | — | 17 | 2 |
| Pa. Uni. Towne Sci. | 2 | — | 59 | — | 61 | — | — | 10 | — | — | 10 | — |
| Moore Sch. E. E. | 5 | — | 38 | — | 43 | 4 | 1 | 7 | — | — | 8 | 0 |
| Pittsburgh Uni. | — | 54 | 157 | — | 211 | 19 | — | — | — | 211 | 211 | 2 |
| Princeton Uni. | 11 | — | — | — | 11 | 15 | — | — | — | — | — | — |

*Enrollment of Graduate Engineering Students, 1939–40—Continued*

| Institutions | Enrollment in Work for the Master's Degree | | | | | | Enrollment in Work for the Doctor's Degree | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Full-Time Resident Students | Part-Time Resident Students | Evening Students | Others | Total | Masters Degrees Conferred in 1938–39 | Full-Time Resident Students | Part-Time Resident Students | Evening Students | Others | Total | Doctors Degrees Conferred in 1938–39 |
| Purdue Uni. | — | — | — | 92 | 92 | 36 | — | — | — | 28 | 28 | 1 |
| Renesselaer | 27 | — | — | — | 27 | 24 | — | — | — | — | — | 1 |
| Rice Inst. | 3 | — | — | — | 3 | — | 1 | — | — | — | 1 | — |
| Rochester Uni. | 3 | 3 | — | — | 6 | 2 | — | — | — | — | — | — |
| Rutgers Uni. | 2 | 8 | — | — | 10 | 2 | — | — | — | — | — | — |
| S. D. Mines | — | 3 | — | — | 3 | 2 | — | — | — | 2 | 2 | — |
| Stanford Uni. | 93 | — | — | — | 93 | 28 | — | — | — | — | — | — |
| Stevens I. T. | — | 11 | 302 | — | 313 | 4 | — | — | — | — | — | — |
| Syracuse Uni. | 2 | 7 | — | — | 9 | 1 | — | — | — | — | — | — |
| Tenn. Uni. | 9 | 46 | — | — | 55 | 11 | — | — | — | — | — | — |
| Texas A. & M. | 8 | 27 | — | 11 | 46 | 14 | — | — | — | 5 | 5 | — |
| Texas Tech. | 5 | 1 | — | — | 6 | 1 | — | — | — | — | — | — |
| Texas Uni. | 34 | 26 | — | — | 60 | 23 | 5 | 6 | — | — | 11 | 5 |
| Tulane Uni. | 2 | 8 | — | — | 10 | 6 | — | — | — | — | — | — |
| Utah Ag. Coll. | 3 | — | — | — | 3 | 1 | — | — | — | — | — | — |
| Utah Uni. | 7 | — | — | — | 7 | 6 | — | — | — | — | — | — |
| Vt. Uni. | 2 | — | — | — | 2 | 0 | — | — | — | — | — | — |
| Va. P. I. | 50 | 10 | — | — | 60 | 31 | — | 1 | — | — | 1 | 0 |
| Va. Uni. | 3 | — | — | — | 3 | 3 | — | — | — | — | — | — |

*Enrollment of Graduate Engineering Students, 1939–40—Continued*

| Institutions | Enrollment in Work for the Master's Degree | | | | | | Enrollment in Work for the Doctor's Degree | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Full-Time Resident Students | Part-Time Resident Students | Evening Students | Others | Total | Masters Degrees Conferred in 1938–39 | Full-Time Resident Students | Part-Time Resident Students | Evening Students | Others | Total | Doctors Degrees Conferred in 1938–39 |
| Wash. St. Coll. | 5 | — | — | — | 5 | 1 | — | — | — | — | — | — |
| Wash., Uni. of | 24 | 7 | — | — | 31 | — | — | 1 | — | — | 1 | — |
| W. Va. Uni. | — | 8 | — | — | 8 | 5 | — | — | — | — | — | — |
| Wisconsin Uni. | — | 32 | — | — | 32 | 16 | — | 14 | — | — | 14 | 8 |
| Worcester P. I. | 4 | 9 | — | — | 13 | 8 | — | — | — | — | — | — |
| Yale Uni. | 30 | 3 | — | 3 | 36 | 5 | 24 | 8 | — | 6 | 38 | 5 |
| U. S. Schools Totals | 2,072 | 666 | 1,742 | 219 | 4,699 | 1,219 | 348 | 170 | 34 | 296 | 848 | 97 |
| Canadian Schools | | | | | | | | | | | | |
| Ecole Poly. | — | 1 | — | — | 1 | 0 | — | 2 | — | — | 2 | 0 |
| McGill Uni. | 6 | — | — | — | 6 | 5 | — | — | — | — | — | — |
| Queen's Uni. | — | — | — | 8 | 8 | 2 | — | — | — | — | — | — |
| Sask. Uni. | 1 | 4 | — | — | 5 | — | — | — | — | — | — | — |
| Toronto Uni. | 4 | 8 | — | — | 12 | 12 | 2 | 2 | — | — | 4 | 3 |
| Totals | 2,083 | 679 | 1,742 | 227 | 4,731 | 1,238 | 350 | 174 | 34 | 296 | 854 | 100 |

## ACCREDITED UNDERGRADUATE CURRICULA *

*(A) Arranged by Institutions*

*University of Alabama*
- Aeronautical Engineering
- Civil Engineering
- Electrical Engineering
- Industrial Engineering
- Mechanical Engineering
- Mining Engineering

*Alabama Polytechnic Institute*
- Electrical Engineering [1939]
- Mechanical Engineering [1939]

*University of Arizona*
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering
- Mining Engineering

*University of Arkansas*
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*Armour Institute of Technology*
- Chemical Engineering
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*Brooklyn Polytechnic Institute*
- Chemical Engineering (Day and 8-year Evening)
- Civil Engineering (*a*)
- Electrical Engineering (*a*)
- Mechanical Engineering (*a*)

*Brown University*
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*Bucknell University*
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering [1939]

*University of California*
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering
- Metallurgical Engineering (Metallurgy)
- Mining Engineering
- Petroleum Engineering

*California Institute of Technology*
- Aeronautical Engineering (Six-year course)
- Chemical Engineering (Five-year course)
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*Carnegie Institute of Technology*
- Chemical Engineering
- Civil Engineering (*a*)
- Electrical Engineering (*a*)
- Industrial (Management) Engineering (*a*)
- Mechanical Engineering (*a*)
- Metallurgical Engineering (*a*)

*Case School of Applied Science*
- Chemical Engineering
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering
- Metallurgical Engineering

*Catholic University of America*
- Aeronautical Engineering [1938]
- Architectural Engineering [1938]
- Civil Engineering [1938]
- Electrical Engineering [1938]
- Mechanical Engineering [1938]

*University of Cincinnati*
- Aeronautical Engineering
- Chemical Engineering
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*The Citadel*
- Civil Engineering

* As of October 20, 1939, and subject to continual revision.

(Note: A date following an accredited curriculum refers to the year of initial accrediting by E.C.P.D. Where no date appears the curriculum was accredited in the interval 1935–1937, which marks the inauguration of the accrediting program.)

*Clarkson College of Technology*
- Chemical Engineering [1938]
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*Clemson Agricultural College*
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*College of the City of New York*
- Civil Engineering (*a*)
- Electrical Engineering (*a*)
- Mechanical Engineering (*a*)

*University of Colorado*
- Architectural Engineering
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*Colorado School of Mines*
- Geological Engineering
- Metallurgical Engineering
- Mining Engineering
- Petroleum Engineering

*Colorado State College*
- Civil Engineering [1938]
- Electrical Engineering [1938]
- Mechanical Engineering [1938]

*Columbia University*
- Chemical Engineering (*b*)
- Civil Engineering (*b*)
- Electrical Engineering (*b*)
- Industrial Engineering (*b*)
- Mechanical Engineering (*b*)
- Metallurgical Engineering (*b*)
- Mining Engineering (*b*)

*Cooper Union Institute of Technology*
- Civil Engineering (*c*)
- Electrical Engineering (*c*)
- Mechanical Engineering (*c*)

*Cornell University*
- Chemical Engineering
- Civil Engineering
- Electrical Engineering
- Industrial (Administrative) Engineering
- Mechanical Engineering

*Dartmouth College*
- Civil Engineering

*University of Delaware*
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*University of Detroit*
- Aeronautical Engineering
- Architectural Engineering
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*Drexel Institute*
- Chemical Engineering
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*Duke University*
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*University of Florida*
- Civil Engineering
- Electrical Engineering
- Industrial Engineering
- Mechanical Engineering

*Georgia School of Technology*
- Aeronautical Engineering
- Chemical Engineering (Excluding Cooperative Curriculum) [1938]
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*Harvard University*
- Civil Engineering (*d*)
- Communication Engineering (*d*)
- Electrical Engineering (*d*)
- Industrial Engineering (Engineering and Business Administration) (*d*)
- Mechanical Engineering (*d*)
- Metallurgical Engineering (Physical Metallurgy) (*d*)
- Sanitary Engineering (*d*)

*University of Idaho*
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering
- Metallurgical Engineering (Metallurgy) [1938]
- Mining Engineering [1938]

*University of Illinois*
- Architectural Engineering
- Ceramic Engineering (Technical Option)
- Chemical Engineering
- Civil Engineering
- Railway Civil Engineering [1939]
- Electrical Engineering
- Railway Electrical Engineering [1939]
- General Engineering (*e*)
- Mechanical Engineering

Railway Mechanical Engineering [1939]
Metallurgical Engineering
Mining Engineering

*Iowa State College*
Agricultural Engineering
Architectural Engineering
Chemical Engineering
Civil Engineering
Electrical Engineering
General Engineering (*e*)
Mechanical Engineering

*State University of Iowa*
Chemical Engineering
Civil Engineering
Electrical Engineering
Mechanical Engineering

*Johns Hopkins University*
Civil Engineering
Electrical Engineering
Mechanical Engineering

*University of Kansas*
Architectural Engineering
Civil Engineering
Electrical Engineering
Mechanical Engineering
Mining Engineering

*Kansas State College*
Agricultural Engineering
Architectural Engineering
Civil Engineering
Electrical Engineering
Mechanical Engineering

*University of Kentucky*
Civil Engineering
Metallurgical Engineering
Mining Engineering

*Lafayette College*
Civil Engineering
Electrical Engineering
Industrial (Administrative) Engineering
Mechanical Engineering
Metallurgical Engineering
Mining Engineering

*Lehigh University*
Chemical Engineering
Civil Engineering
Electrical Engineering
Industrial Engineering
Mechanical Engineering
Metallurgical Engineering
Mining Engineering

*Louisiana State University*
Chemical Engineering [1939]
Civil Engineering
Electrical Engineering
Mechanical Engineering
Petroleum Engineering

*University of Louisville*
Chemical Engineering
Civil Engineering
Electrical Engineering
Mechanical Engineering

*University of Maine*
Civil Engineering
Electrical Engineering
General Engineering (*e*)
Mechanical Engineering

*Marquette University*
Civil Engineering
Electrical Engineering
Mechanical Engineering

*University of Maryland*
Civil Engineering
Electrical Engineering
Mechanical Engineering

*Massachusetts Institute of Technology*
Aeronautical Engineering
Building Engineering and Construction
Chemical Engineering
Civil Engineering
Electrical Engineering
Electrochemical Engineering
General Engineering (*e*)
Industrial Engineering (Business and Engineering Administration)
Mechanical Engineering
Metallurgical Engineering (Metallurgy)
Mining Engineering
Naval Architecture and Marine Engineering (Including Marine Transportation) [1939]
Public Health Engineering
Sanitary Engineering

*University of Michigan*
Aeronautical Engineering
Chemical Engineering
Civil Engineering
Electrical Engineering
Engineering Mechanics
Mechanical Engineering
Metallurgical Engineering
Naval Architecture and Marine Engineering
Transportation Engineering

*Michigan College of Mining and Technology*
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering
- Metallurgical Engineering
- Mining Engineering

*Michigan State College*
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*University of Minnesota*
- Aeronautical Engineering
- Chemical Engineering
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering
- Metallurgical Engineering
- Mining Engineering
- Petroleum Engineering

*University of Missouri*
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*Missouri School of Mines and Metallurgy*
- Ceramic Engineering
- Civil Engineering
- Electrical Engineering
- Metallurgical Engineering
- Mining (Mine) Engineering (Includes Petroleum Engineering Option)

*Montana School of Mines*
- Geological Engineering
- Metallurgical Engineering
- Mining Engineering

*Montana State College*
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*University of Nebraska*
- Agricultural Engineering
- Architectural Engineering
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*University of Nevada*
- Electrical Engineering
- Mechanical Engineering [1938]
- Mining Engineering

*University of New Hampshire*
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*University of New Mexico*
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*New Mexico State College*
- Civil Engineering [1938]
- Electrical Engineering [1938]
- Mechanical Engineering [1938]

*New York University*
- Aeronautical Engineering
- Chemical Engineering (Day and 7-year Evening)
- Civil Engineering (*a*)
- Electrical Engineering (*a*)
- Mechanical Engineering (*a*)

*New York State College of Ceramics* (At Alfred University)
- Ceramic Engineering

*Newark College of Engineering*
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*North Carolina State College*
- Ceramic Engineering
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*University of North Dakota*
- Chemical Engineering [1939]
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering
- Mining Engineering

*Northeastern University*
- Civil Engineering [1939]
- Electrical Engineering [1939]
- Industrial Engineering [1939]
- Mechanical Engineering [1939]

*Northwestern University*
- Civil Engineering [1938]
- Electrical Engineering [1938]
- Mechanical Engineering [1938]

*Norwich University*
- Civil Engineering
- Electrical Engineering

*Ohio State University*
- Ceramic Engineering
- Chemical Engineering
- Civil Engineering
- Electrical Engineering
- Industrial Engineering
- Mechanical Engineering
- Metallurgical Engineering
- Mining (Mine) Engineering

*University of Oklahoma*
- Architectural Engineering
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering
- Petroleum Engineering (Production Option)

*Oklahoma A. & M. College*
- Civil Engineering
- Electrical Engineering
- Industrial Engineering
- Mechanical Engineering

*Oregon State College*
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*University of Pennsylvania*
- Chemical Engineering
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*Pennsylvania State College*
- Architectural Engineering
- Ceramic Engineering (Ceramics) [1938]
- Chemical Engineering
- Civil Engineering
- Electrical Engineering
- Electrochemical Engineering
- Fuel Technology [1938]
- Industrial Engineering
- Mechanical Engineering
- Metallurgical Engineering (Metallurgy) [1938]
- Mining Engineering [1938]
- Petroleum and Natural Gas Engineering [1938]
- Sanitary Engineering

*University of Pittsburgh*
- Chemical Engineering
- Civil Engineering
- Electrical Engineering
- Industrial Engineering
- Mechanical Engineering
- Metallurgical Engineering
- Mining Engineering
- Petroleum Engineering

*Polytechnic Institute of Brooklyn* (See Brooklyn Polytechnic Institute)

*Pratt Institute*
- Electrical Engineering [1939]
- Mechanical Engineering [1939]

*Princeton University*
- Chemical Engineering
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*Purdue University*
- Chemical Engineering
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*Rennselaer Polytechnic Institute*
- Aeronautical Engineering [1938]
- Chemical Engineering
- Civil Engineering
- Electrical Engineering
- Industrial Engineering [1938]
- Mechanical Engineering
- Metallurgical Engineering [1938]

*Rhode Island State College*
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*Rice Institute*
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*University of Rochester*
- Mechanical Engineering

*Rose Polytechnic Institute*
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*Rutgers University*
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering
- Sanitary Engineering

*University of Santa Clara*
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*South Dakota State College*
- Civil Engineering
- Electrical Engineering
- Mechanical Engineering

*South Dakota State School of Mines*
- Civil Engineering
- Electrical Engineering
- Metallurgical Engineering
- Mining Engineering

*University of Southern California*
- Petroleum Engineering

*Southern Methodist University*
- Civil Engineering [1939]
- Electrical Engineering [1939]
- Mechanical Engineering [1939]

*Stanford University*
Civil Engineering
Electrical Engineering
Mechanical Engineering
Metallurgical Engineering
Mining Engineering
Petroleum Engineering
*Stevens Institute of Technology*
General Engineering (*e*)
*Swarthmore College*
Civil Engineering
Electrical Engineering
Mechanical Engineering
*Syracuse University*
Civil Engineering
Electrical Engineering
Industrial (Administrative) Engineering
Mechanical Engineering
*University of Tennessee*
Chemical Engineering [1939]
Civil Engineering
Electrical Engineering
Mechanical Engineering
*University of Texas*
Architectural Engineering [1938]
Civil Engineering
Electrical Engineering
Mechanical Engineering
Petroleum (Petroleum Production) Engineering
*A. & M. College of Texas*
Civil Engineering
Electrical Engineering
Mechanical Engineering
Petroleum Engineering
*Texas Technological College*
Civil Engineering
Electrical Engineering
Mechanical Engineering
*Tufts College*
Civil Engineering
Electrical Engineering
Mechanical Engineering
*Tulane University of Louisiana*
Civil Engineering
Electrical Engineering
Mechanical Engineering
*University of Tulsa*
Petroleum Engineering (Including Options in Refining and Production) [1939]
*Union College*
Civil Engineering
Electrical Engineering
*United States Coast Guard Academy*
General Engineering [1939] (*e*)
*University of Utah*
Civil Engineering
Electrical Engineering
Mechanical Engineering
Metallurgical Engineering
Mining Engineering
*Utah State Agricultural College*
Civil Engineering [1938]
*Vanderbilt University*
Civil Engineering [1939]
Electrical Engineering [1939]
Mechanical Engineering [1939]
*University of Vermont*
Electrical Engineering
*University of Virginia*
Civil Engineering
Electrical Engineering
Mechanical Engineering
*Virginia Military Institute*
Civil Engineering
Electrical Engineering
*Virginia Polytechnic Institute*
Ceramic Engineering [1938]
Chemical Engineering [1938]
Civil Engineering
Electrical Engineering
Industrial Engineering
Mechanical Engineering
*Washington University*
Architectural Engineering
Civil Engineering
Electrical Engineering
Industrial (Administrative) Engineering
Mechanical Engineering
*University of Washington*
Aeronautical Engineering
Ceramic Engineering
Chemical Engineering
Civil Engineering
Electrical Engineering
Mechanical Engineering
Metallurgical Engineering
Mining Engineering
*State College of Washington*
Architectural Engineering
Civil Engineering
Electrical Engineering (Basic and Hydro-Electric Options)
Mechanical Engineering (Basic Option)
Metallurgical Engineering
Mining Engineering

*Webb Institute of Naval Architecture*
Naval Architecture and Marine Engineering
*West Virginia University*
Civil Engineering
Electrical Engineering
Mechanical Engineering
Mining Engineering
*University of Wisconsin*
Chemical Engineering
Civil Engineering
Electrical Engineering
Mechanical Engineering
Metallurgical Engineering
Mining Engineering
*Worcester Polytechnic Institute*
Civil Engineering
Electrical Engineering
Mechanical Engineering
*Yale University*
Chemical Engineering
Civil Engineering
Electrical Engineering
Mechanical Engineering
Metallurgical Engineering (Metallurgy)

### (*B*) *Arranged by Curricula*

*Aeronautical Engineering*
University of Alabama
California Institute of Technology (Six-year course)
Catholic University of America [1938]
University of Cincinnati
University of Detroit
Georgia School of Technology
Massachusetts Institute of Technology
University of Michigan
University of Minnesota
New York University
Rensselaer Polytechnic Institute [1938]
University of Washington
*Agricultural Engineering*
Iowa State College
Kansas State College
University of Nebraska
*Architectural Engineering*
Catholic University of America [1938]
University of Colorado
University of Detroit
University of Illinois
Iowa State College
University of Kansas
Kansas State College
University of Nebraska
University of Oklahoma
Pennsylvania State College
University of Texas [1938]
Washington University
State College of Washington
*Ceramic Engineering*
University of Illinois (Technical Option)
Missouri School of Mines and Metallurgy
New York State College of Ceramics (at Alfred University)
North Carolina State College
Ohio State University
Pennsylvania State College (Ceramics) [1938]
Virginia Polytechnic Institute [1938]
University of Washington
*Chemical Engineering*
Armour Institute of Technology
Brooklyn Polytechnic Institute (Day and 8-year Evening)
California Institute of Technology (Five-year course)
Carnegie Institute of Technology
Case School of Applied Science
University of Cincinnati
Clarkson College of Technology [1938]
Columbia University (*b*)
Cornell University
Drexel Institute
Georgia School of Technology (Excluding Cooperative Curriculum) [1938]
University of Illinois
Iowa State College
State University of Iowa
Lehigh University
Louisiana State University [1939]
University of Louisville
Massachusetts Institute of Technology
University of Michigan
University of Minnesota

New York University (Day and 7-year Evening)
University of North Dakota [1939]
Ohio State University
University of Pennsylvania
Pennsylvania State College
University of Pittsburgh
Princeton University
Purdue University
Rensselaer Polytechnic Institute
University of Tennessee [1939]
Virginia Polytechnic Institute [1938]
University of Washington
University of Wisconsin
Yale University

*Civil Engineering*

University of Alabama
University of Arizona
University of Arkansas
Armour Institute of Technology
Brooklyn Polytechnic Institute (*a*)
Brown University
Bucknell University
University of California
California Institute of Technology
Carnegie Institute of Technology (*a*)
Case School of Applied Science
Catholic University of America [1938]
University of Cincinnati
The Citadel
Clarkson College of Technology
Clemson Agricultural College
College of the City of New York (*a*)
University of Colorado
Colorado State College [1938]
Columbia University (*b*)
Cooper Union Institute of Technology (*c*)
Cornell University
Dartmouth College
University of Delaware
University of Detroit
Drexel Institute
Duke University
University of Florida
Georgia School of Technology
Harvard University (*d*)
University of Idaho
University of Illinois (Civil Engineering)
University of Illinois (Railway Civil Engineering) [1939]
Iowa State College
State University of Iowa
Johns Hopkins University
University of Kansas
Kansas State College
University of Kentucky
Lafayette College
Lehigh University
Louisiana State University
University of Louisville
University of Maine
Marquette University
University of Maryland
Massachusetts Institute of Technology (Civil Engineering)
Massachusetts Institute of Technology (Building Engineering and Construction)
University of Michigan (Civil Engineering)
University of Michigan (Engineering Mechanics)
University of Michigan (Transportation Engineering)
Michigan College of Mining and Technology
Michigan State College
University of Minnesota
University of Missouri
Missouri School of Mines and Metallurgy
Montana State College
University of Nebraska
University of New Hampshire
University of New Mexico
New Mexico State College [1938]
New York University (*a*)
Newark College of Engineering
North Carolina State College
University of North Dakota
Northeastern University [1939]
Northwestern University [1938]
Norwich University
Ohio State University
University of Oklahoma
Oklahoma A. & M. College
Oregon State College
University of Pennsylvania
Pennsylvania State College
University of Pittsburgh
Princeton University
Purdue University
Rensselaer Polytechnic Institute

Rhode Island State College
Rice Institute
Rose Polytechnic Institute
Rutgers University
University of Santa Clara
South Dakota State College
South Dakota State School of Mines
Southern Methodist University [1939]
Stanford University
Swarthmore College
Syracuse University
University of Tennessee
University of Texas
A. & M. College of Texas
Texas Technological College
Tufts College
Tulane University of Louisiana
Union College
University of Utah
Utah State Agricultural College [1938]
Vanderbilt University [1939]
University of Virginia
Virginia Military Institute
Virginia Polytechnic Institute
Washington University
University of Washington
State College of Washington
West Virginia University
University of Wisconsin
Worcester Polytechnic Institute
Yale University

*Electrical Engineering*

University of Alabama
Alabama Polytechnic Institute [1939]
University of Arizona
University of Arkansas
Armour Institute of Technology
Brooklyn Polytechnic Institute (*a*)
Brown University
Bucknell University
University of California
California Institute of Technology
Carnegie Institute of Technology (*a*)
Case School of Applied Science
Catholic University of America [1938]
University of Cincinnati
Clarkson College of Technology
Clemson Agricultural College
College of the City of New York (*a*)
University of Colorado
Colorado State College [1938]
Columbia University (*b*)
Cooper Union Institute of Technology (*c*)
Cornell University
University of Delaware
University of Detroit
Drexel Institute
Duke University
University of Florida
Georgia School of Technology
Harvard University (Electrical Engineering) (*d*)
Harvard University (Communication Engineering) (*d*)
University of Idaho
University of Illinois (Electrical Engineering)
University of Illinois (Railway Electrical Engineering) [1939]
Iowa State College
State University of Iowa
Johns Hopkins University
University of Kansas
Kansas State College
Lafayette College
Lehigh University
Louisiana State University
University of Louisville
University of Maine
Marquette University
University of Maryland
Massachusetts Institute of Technology
University of Michigan
Michigan College of Mining and Technology
Michigan State College
University of Minnesota
University of Missouri
Missouri School of Mines and Metallurgy
Montana State College
University of Nebraska
University of Nevada
University of New Hampshire
University of New Mexico
New Mexico State College [1938]
New York University (*a*)
Newark College of Engineering
North Carolina State College
University of North Dakota

Northeastern University [1939]
Northwestern University [1938]
Norwich University
Ohio State University
University of Oklahoma
Oklahoma A. & M. College
Oregon State College
University of Pennsylvania
Pennsylvania State College
University of Pittsburgh
Pratt Institute [1939]
Princeton University
Purdue University
Rensselaer Polytechnic Institute
Rhode Island State College
Rice Institute
Rose Polytechnic Institute
Rutgers University
University of Santa Clara
South Dakota State College
South Dakota State School of Mines
Southern Methodist University [1939]
Stanford University
Swarthmore College
Syracuse University
University of Tennessee
University of Texas
A. & M. College of Texas
Texas Technological College
Tufts College
Tulane University of Louisiana
Union College
University of Utah
Vanderbilt University [1939]
University of Vermont
University of Virginia
Virginia Military Institute
Virginia Polytechnic Institute
Washington University
University of Washington
State College of Washington (Basic and Hydro-Electric Options)
West Virginia University
University of Wisconsin
Worcester Polytechnic Institute
Yale University

*Electrochemical Engineering*

Massachusetts Institute of Technology
Pennsylvania State College

*Fuel Technology*

Pennsylvania State College [1938]

*General Engineering* (*e*)

University of Illinois
Iowa State College
University of Maine
Massachusetts Institute of Technology
Stevens Institute of Technology
United States Coast Guard Academy [1939]

*Industrial Engineering*

University of Alabama
Carnegie Institute of Technology (Management Engineering) (*a*)
Columbia University (*b*)
Cornell University (Administrative Engineering)
University of Florida
Harvard University (Engineering and Business Administration) (*d*)
Lafayette College (Administrative Engineering)
Lehigh University
Massachusetts Institute of Technology (Business and Engineering Administration)
Northeastern University [1939]
Ohio State University
Oklahoma A. & M. College
Pennsylvania State College
University of Pittsburgh
Rensselaer Polytechnic Institute [1938]
Syracuse University (Administrative Engineering)
Virginia Polytechnic Institute
Washington University (Administrative Engineering)

*Mechanical Engineering*

University of Alabama
Alabama Polytechnic Institute [1939]
University of Arizona
University of Arkansas
Armour Institute of Technology
Brooklyn Polytechnic Institute (*a*)
Brown University
Bucknell University [1939]
University of California
California Institute of Technology
Carnegie Institute of Technology (*a*)
Case School of Applied Science
Catholic University of America [1938]

University of Cincinnati
Clarkson College of Technology
Clemson Agricultural College
College of the City of New York (*a*)
University of Colorado
Colorado State College [1938]
Columbia University (*b*)
Cooper Union Institute of Technology (*c*)
Cornell University
University of Delaware
University of Detroit
Drexel Institute
Duke University
University of Florida
Georgia School of Technology
Harvard University (*d*)
University of Idaho
University of Illinois (Mechanical Engineering)
University of Illinois (Railway Mechanical Engineering) [1939]
Iowa State College
State University of Iowa
Johns Hopkins University
University of Kansas
Kansas State College
Lafayette College
Lehigh University
Louisiana State University
University of Louisville
University of Maine
Marquette University
University of Maryland
Massachusetts Institute of Technology
University of Michigan
Michigan College of Mining and Technology
Michigan State College
University of Minnesota
University of Missouri
Montana State College
University of Nebraska
University of Nevada [1938]
University of New Hampshire
University of New Mexico
New Mexico State College [1938]
New York University (*a*)
Newark College of Engineering
North Carolina State College
University of North Dakota
Northeastern University [1939]
Northwestern University [1938]
Ohio State University
University of Oklahoma
Oklahoma A. & M. College
Oregon State College
University of Pennsylvania
Pennsylvania State College
University of Pittsburgh
Pratt Institute [1939]
Princeton University
Purdue University
Rensselaer Polytechnic Institute
Rhode Island State College
Rice Institute
University of Rochester
Rose Polytechnic Institute
Rutgers University
University of Santa Clara
South Dakota State College
Southern Methodist University [1939]
Stanford University
Swarthmore College
Syracuse University
University of Tennessee
University of Texas
A. & M. College of Texas
Texas Technological College
Tufts College
Tulane University of Louisiana
University of Utah
Vanderbilt University [1939]
University of Virginia
Virginia Polytechnic Institute
Washington University
University of Washington
State College of Washington (Basic Option)
West Virginia University
University of Wisconsin
Worcester Polytechnic Institute
Yale University

*Metallurgical Engineering*

University of California (Metallurgy)
Carnegie Institute of Technology (*a*)
Case School of Applied Science
Colorado School of Mines
Columbia University (*b*)
Harvard University (Physical Metallurgy) (*d*)
University of Idaho (Metallurgy) [1938]
University of Illinois
University of Kentucky

Lafayette College
Lehigh University
Massachusetts Institute of Technology (Metallurgy)
University of Michigan
Michigan College of Mining and Technology
University of Minnesota
Missouri School of Mines and Metallurgy
Montana School of Mines
Ohio State University
Pennsylvania State College (Metallurgy) [1938]
University of Pittsburgh
Rensselaer Polytechnic Institute [1938]
South Dakota State School of Mines
Stanford University
University of Utah
University of Washington
State College of Washington
University of Wisconsin
Yale University (Metallurgy)

*Mining Engineering*

University of Alabama
University of Arizona
University of California
Colorado School of Mines (Mining Engineering)
Colorado School of Mines (Geological Engineering)
Columbia University (*b*)
University of Idaho [1938]
University of Illinois
University of Kansas
University of Kentucky
Lafayette College
Lehigh University
Massachusetts Institute of Technology
Michigan College of Mining and Technology
University of Minnesota
Missouri School of Mines and Metallurgy (Mine Engineering) (Including Petroleum Engineering Option)
Montana School of Mines (Mining Engineering)
Montana School of Mines (Geological Engineering)
University of Nevada
University of North Dakota
Ohio State University (Mine Engineering)
Pennsylvania State College [1938]
University of Pittsburgh
South Dakota State School of Mines
Stanford University
University of Utah
University of Washington
State College of Washington
West Virginia University
University of Wisconsin

*Naval Architecture and Marine Engineering*

Massachusetts Institute of Technology (Including Marine Transportation) [1939]
University of Michigan
Webb Institute of Naval Architecture

*Petroleum Engineering*

University of California
Colorado School of Mines
Louisiana State University
University of Minnesota
University of Oklahoma (Production Option)
Pennsylvania State College (Petroleum and Natural Gas Engineering) [1938]
University of Pittsburgh
University of Southern California
Stanford University
University of Texas (Petroleum Production Engineering)
A. & M. College of Texas
University of Tulsa (Including Options in Refining and Production) [1939]

*Sanitary Engineering*

Harvard University (*d*)
Massachusetts Institute of Technology (Sanitary Engineering)
Massachusetts Institute of Technology (Public Health Engineering)
Pennsylvania State College
Rutgers University

*Explanatory Notes*

(*a*) Accrediting applies to day and evening curricula.

(*b*) Accrediting applies to the four-year and five-year curricula leading to the Bachelor of Science degree.

(*c*) Accrediting applies to day curriculum only. Action on evening curriculum deferred pending granting of degrees.

(*d*) Accrediting applies only to curriculum as submitted to E. C. P. D. and upon completion of which a certificate is issued by Harvard University certifying that the student has pursued such a curriculum.

(*e*) The accrediting of a curriculum in general engineering implies satisfactory training in engineering sciences and in the basic subjects pertaining to several fields of engineering; it does not imply the accrediting, as separate curricula, of those component portions of the curriculum such as civil, mechanical or electrical engineering that are usually offered as complete professional curricula leading to degrees in these particular fields.

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## REPORTED PROGRESS ON SPECIAL COMMITTEE ON AIMS AND SCOPE OF ENGINEERING CURRICULA

At the meeting of the Council and Institutional Delegates of the Society held in June, 1939, there was a discussion of the action of certain groups of engineers, particularly representatives of the National Society of Professional Engineers, who advocated a change in the New York State education law which would have tended to require young engineers seeking professional licensure to pursue a combined college program composing two years of Liberal Arts and four years of Engineering. As a result of this discussion a special committee of the Society was appointed to consider this matter and to present a report at a special meeting of the Society to be held at the time of the meeting of the Association of Land-Grant Colleges and Universities in November.

Pursuant to its instructions, the committee met for a period of three days in Pittsburgh early this fall and prepared a tentative report. This report was presented at Washington on November 16th, with the purpose of securing opinions to guide the committee in preparing its report in final form. Because the report as presented was merely tentative, it was not released for publication.

Since then the committee has received numerous opinions concerning the report and met in Chicago on December 16th. As soon as the report is in final form it will be released for publication in the JOURNAL.

H. P. HAMMOND

# A DISCUSSION OF "PRE-ENGINEERING COLLEGE EDUCATION"*

By GEORGE C. ERNST

Assistant Professor of Civil Engineering, University of Maryland

The writer, having been quoted by Dr. Steinman in the December issue of the JOURNAL, wishes to take this opportunity to comment more completely on the subject of "Pre-Engineering College Education." The quotation chosen by Dr. Steinman was taken from a paper † which attempted to point out that present teaching loads in many institutions adversely affect the quality of engineering instruction. Previously suggested remedies, such as the 5- or 6-year curriculum, were briefly discussed near the close of the paper. The issue of pre-engineering education, however, should be considered from the standpoint of the desires of the entire engineering group, educators and practitioners alike. If the existing encroachment upon the field of the liberal arts colleges receives the approval of a majority in the two groups, the present 4-year curriculum does not need to be changed.

There certainly can be no question that engineering exists as a profession, but it is apparent also that the 4-year period no longer meets that standard. It is not difficult to recognize that, in general, our present system does not produce a professionally trained man. If this condition meets with no objection, the pre-engineering term is not necessary.

The major question appears to be: "Does the engineering profession wish (rather than need) a professional type of education as typified by the leading medical and law schools?" Certainly the answer to such a question should be formulated only after a canvass of the opinions of all of the individuals comprising the present educational and practising groups.

The present accrediting system also merits attention with regard to the improvement of engineering education. It requires little imagination to visualize the extreme difficulties and prejudices which the E. C. P. D. inspection committees have had to overcome. It may be readily noted, moreover, that the quality ( and quantity)

* Written discussions of 500 words or less are invited of any article appearing in the Journal.

† "Professional Standards vs. Mass Production in Engineering Schools," Civil Engineering, September, 1939.

of laboratory equipment and the content of the 4-year curriculum have been markedly improved by the inspections of the smaller schools. The following questions, however, will require consideration in the very near future, irrespective of our wishes in the matter.

1. Are subsequent inspections to be of a perfunctory character or will there be a further stiffening of recommendations over a relatively short period of time?

2. When will an attempt be made to stabilize, within appropriate limits, the ratio of enrolment to full time *engineering* teaching staff? (It is difficult to conceive of the present situation as a desirable one.)

3. Are all the 118 schools (an average of almost 2.5 per state), now accredited in one or more curricula, needed for the production of engineers?

In conclusion, it is true that little concern need be felt for those engineering schools fortunate enough to have traditions, precedents, and administrative leadership which are capable of maintaining adequate standards. On the other hand, those remaining institutions (which I would estimate at 40 per cent or more of the present accredited group) will always need critical study and control if professional training is desired.

## CONFERENCE ON CIVIL ENGINEERING*

*The Executive Committee* for 1938–1939 included F. T. Mavis (The Pennsylvania State College),† chairman; H. C. Bird (Duke University), Immediate Past-Chairman; F. W. Stubbs, Jr. (Rhode Island State College), Secretary; M. W. Furr (Kansas State College), Editor; H. T. Heald (Armour Institute of Technology), Paul P. Rice (Lafayette College), and Hale Sutherland (Lehigh University), Directors. Conferences were arranged by nine committees whose work is briefly summarized herein. The roster of standing committees was published in the *Civil Engineering Bulletin*, Vol. 4, No. 1, December, 1938. In addition to about 70 members of standing committees there were many more who served on subcommittees or otherwise participated in the work of the Division. Nearly 40 papers and written discussions were presented at the Division's conferences.

The Annual Civil Engineering Division Dinner was arranged by a committee under the chairmanship of Elton D. Walker (The Pennsylvania State College). J. S. Crandell (University of Illinois), and J. R. Shank (Ohio State University) related—with fact and anecdote—the colorful story of the people of Central Pennsylvania. Group singing was under the leadership of O. S. Zelner (University of Minnesota) and a squad-chorus of civil engineers.

Officers for 1939–1940 are: M. W. Furr (Kansas State College), Chairman; Paul P. Rice (Lafayette College), Secretary; E. E. Bauer (University of Illinois), Editor; L. G. Straub (University of Minnesota), F. W. Stubbs, Jr. (Rhode Island State College), and H. T. Heald (Armour Institute of Technology), Directors.

*Committee on Library Facilities.*—The final report of this special committee was presented by L. E. Grinter (Armour Institute of Technology) Chairman. The Committee of the whole consisted of 191 engineers in teaching, research, and practice. For the purpose of compiling a check list of outstanding monographs in civil engineering and the related academic subjects, the field of subject matter was divided into six major divisions. Book lists, one prepared by each individual committee member to cover a specified subdivision, were correlated by the six division chairmen and subsequently by the coördinating committee on Library Facilities. A

* Report of conferences on civil engineering held at 47th annual meeting, S. P. E. E., Pennsylvania State College, June 19–23, 1939.

† University of Iowa before July 1, 1939.

total of about 750 titles are listed in the final report. There is no thought that this list contains all of the good books that should be available in a Civil Engineering library. It is doubtful whether any list will ever be produced which does not omit many valuable books and include some mediocre ones. Each of the fifty-odd groups of books is the result of coördination of three or four lists and the work of coördination has passed through the hands of at least five persons in each instance. The Library Facilities Committee and the Civil Engineering Division is indebted to the Macmillan Company for publishing its 34-page report for distribution at the 1939 Convention.

1. *Educational Policy and Teaching Methods.*—H. T. Heald (Armour Institute of Technology) Chairman. The Committee planned its conference around the topic "Evaluation of the Civil Engineering Product." Dr. C. C. Williams, president of Lehigh University, discussed needed changes in the civil engineering curriculum, pointing out that many curricula are suffering from obsolescence, and suggesting new fields of civil engineering training which might properly be developed to meet the changing responsibilities of the profession. Mr. Enoch R. Needles of New York discussed the qualifications of the civil engineering graduate from the point of view of the employer, and suggested ways in which the graduate's general cultural background might be improved by altering the existing four-year civil engineering course to make room for suitable cultural and broadening subjects. Members of the conference discussed extensively the length of curriculum, the qualifications of the graduates, cultural development, and methods of actually measuring the effectiveness of the curriculum by making an objective study of the effectiveness with which civil engineering graduates had met their manifold responsibilities.

The Chairman pointed out that the Committee had hoped to develop a plan for measuring the effectiveness of engineering graduates through circulation of questionnaires to graduates of the last ten years, but had been unable to satisfy itself on methods of procedure.

2. *Structural Engineering.*—Frank Kerekes (Iowa State College)) Chairman. Centered about the theme, "Trends in Structural Engineering Education," three papers were presented respectively by R. A. Caughey (Iowa State College) and C. E. Sandstedt (A. & M. College of Texas) on "The Undergraduate Course in Reinforced Concrete Design," and Max M. Frocht (Carnegie Institute of Technology) on "The Place of Photoelasticity in the Teaching of Structural Analysis."

It is significant that each of these authors discussed the inclusion of such topics as continuous and fixed beams, continuous frames,

and elastic arches as a part of the undergraduate course for all civil engineering students. In the discussion from the floor the need for advanced and new structural theory, method and process in the curriculum was recognized but emphasis was placed upon the development of clear and accurate concepts by the undergraduate students.

As long as the curriculum in Civil Engineering is to be limited to four years, new developments in structural engineering can be included only by reducing to a minimum the time devoted to class room consideration of descriptive matter and manual skill. A survey * of course outlines in typical schools of engineering shows that this solution is being employed by a large group.

3. *Sanitary Engineering.*—Harold A. Vagtborg (Armour Institute of Technology) Chairman. The program was divided into two parts—the sanitary engineering curriculum, and the sanitary engineering laboratory and its functions. W. E. Stanley (Cornell University) stimulated a lively discussion by his paper entitled "Should Short Courses be Given for the Benefit of Water and Sewage Plant Operators?" L. V. Carpenter (New York University), W. L. Malcolm (Cornell University), and others discussed the situation in New York State and urged that the universities be given an opportunity to advise in the content and conduct of short schools sponsored by the State Health Departments. R. B. Wiley (Purdue University) explained the coöperative arrangement existing between Purdue University and the State Department of Health of Indiana.

The following papers were read in the absence of the authors: "E. C. P. D. Accredited Sanitary Engineering Curricula," by J. K. Finch (Columbia University); "What We Expect of the Sanitary Engineer," by Samuel A. Greeley and Paul Hansen (Chicago). In discussing these papers, George E. Barnes (Case School of Applied Science) favored a sanitary engineering curriculum designed to fit the field of sanitary engineering rather than the present E. C. P. D. standard for civil engineering. He proposed to eliminate structural design, advanced surveying, and astronomy in favor of biology, bacteriology, chemistry of water and sewage, and a more intensive study of water and sewage treatment. C. J. Velz (Manhattan College) added that the public service angle should be considered as well as the requirements for consulting work when sanitary engineering curricula are being developed.

The period devoted to laboratory facilities included short descriptions of the sanitary engineering laboratories at Cornell, New

* "Scope and Organization of a Sequence of Courses in Structures in Relation to the Civil Engineering Curriculum," by Frank Kerekes, JOURNAL OF ENGINEERING EDUCATION, Vol. XXIX, No. 4, December, 1938.

York, Harvard, and Stanford Universities, the University of Illinois, and Armour Institute of Technology. E. R. Stapley (Oklahoma A. & M.) in the absence of Gordon M. Fair discussed the laboratory work at Harvard and suggested that any laboratory should be designed with flexibility to demonstrate scientific principles, to permit isolation of various phases of work, and to provide facilities for concurrent studies.

W. L. Malcolm (Cornell University) described the sanitary laboratory, experimental water plant and experimental sewage treatment plant at Queens University. This was planned for instruction and for plant scale operation on the campus as a substitute for extended inspection trips.

H. B. Gotaas (University of North Carolina) described the new laboratory facilities of the School of Public Health at the University of North Carolina. The laboratory is designed for the usual work in water and sewage chemistry and it is further equipped for studies in industrial hygiene.

The following papers were presented as a part of the program: "The Sanitary Engineering Laboratory at Cornell University," by Charles L. Walker; "Sanitary Laboratory at New York University," by Lewis V. Carpenter; "The Functions of the Sanitary Laboratory," by Paul J. Beard (Stanford University); "Needs for Research in Sanitary Engineering," by Willem Rudolfs (New Jersey Agricultural Experiment Station).

4. *Transportation.*—Harry Rubey (University of Missouri) Chairman. During the year the Committee circulated a questionnaire among teachers and practitioners to obtain a consensus regarding its future educational activities.

The following papers were presented: "Summary of Report of the Committee on Education of the American Road Builders Association," by M. W. Furr (Kansas State College); "Summary of Report of Committee on Highway Engineering Education, Am. Soc. C. E.," by Julius Adler, Philadelphia (by title); "Railroading as a Career for Engineering Graduates," by Elmer T. Howson (Chicago); and a report of the Transportation Committee, by Harry Rubey, Chairman.*

At the Conference the major discussions centered around ways and means of reviving interest in transportation among civil engineering students and among the transportation agencies. The need of satisfactory texts and reference material to meet modern requirements was evident.

The encouraging feature of the conference was an almost complete unanimity of opinion regarding the promising future for

* The report of the Committee and the papers presented at the Conference may be obtained from the Chairman, Harry Rubey, University of Missouri.

properly qualified young engineers in the transportation industry, and a considerable agreement as to the procedure for training and selecting these men.

5. *Applied Hydraulics.*—L. G. Straub (University of Minnesota) Chairman. The Conference on Applied Hydraulics was devoted entirely to matters of educational policy and procedures as contrasted with technical and professional research reports which had been sponsored two weeks previously jointly by the Civil Engineering Division of S. P. E. E. and the Iowa Institute of Hydraulic Research at Iowa City.

The program included a careful analysis of data obtained in two surveys conducted by subcommittees under the chairmanship respectively of Glen N. Cox (Louisiana State University) and W. M. Lansford (University of Illinois). Other papers on the program were on "The Demonstrational Lecture Method of Teaching Hydraulics," by Lorenz G. Straub (University of Minnesota) and a "Report and Recommendations of Committee on Hydraulics," by J. G. Woodburn (University of Wisconsin). F. T. Mavis (The Pennsylvania State College) presented a report on the Hydraulics Conference held at Iowa City June 12–15.

One of the survey reports, which was presented by Professor Cox, concerned "A Study of Requirements for Graduate Work in Hydraulics." A general discussion was given of the method of carrying on graduate work, with hydraulics as a major which leads to either the Master's or Doctor's degree. The analysis covered requirements to be expected by various institutions with reference to the minor, the thesis, and the different examinations, such as language, comprehensive and thesis examinations. An interesting finding was the overwhelming majority of faculty advisors to graduate students recommending mathematics as a minor for hydraulics.

Professor Lansford presented the analysis of "A Survey of the Methods of Teaching and the Value of Undergraduate Thesis Work," summarizing replies received from over one hundred engineering colleges. About one-half of these institutions offer undergraduate thesis work and most of them include thesis work in hydraulics. The general subject of undergraduate theses was a quite mooted one from the floor, emphasis being given to the need of adequate equipment and facilities as well as sufficient teaching staff to make undergraduate thesis work expedient.

6. *Construction Education.*—M. I. Evinger (University of Nebraska) Chairman. John E. Burchard (Massachusetts Institute of Technology), in discussing "Needs for Research in the Building Industry," outlined five groups of studies: social-political-economic studies, studies of building materials, studies of building productivity, studies of amenities, and studies in integration.

Lowell J. Chawner, Chief of the Division of Economic Research, U. S. Department of Commerce, in an address on "Scientific Measurement and Economic Behavior," directed attention to the close similarity between the science of economic behavior and its counterpart in the engineering sciences such as hydraulics and structural analysis.

Adolph J. Ackerman, Development Engineer, Dravo Corporation, Pittsburgh, Pa., in a paper on "The Civil Engineer in the Construction Field," discussed the trend in the construction industry toward a more scientific approach of construction problems. More technically trained men are finding employment in the construction industry, and this field, therefore, deserves greater emphasis in engineering curricula, he concluded.

F. W. Stubbs, Jr. (Rhode Island State College), submitted a progress report of a Subcommittee on "Survey of Content of Courses in Construction." An inventory of institutional-catalog descriptions made in 1939 indicates that 48 or 49 institutions are now offering some form of construction courses.

M. I. Evinger (University of Nebraska) submitted a progress report of the Committee on Construction Education.

7. *Foundations and Soil Mechanics.*—E. E. Bauer (University of Illinois) Chairman. Three papers were presented at the conference: "Theories of Failure of Materials and the Shearing Resistance of Soils," by P. C. Rutledge (Purdue University), followed by a motion picture entitled "Engineering Aspects of Soil Behavior"; "Triaxial Compression Tests for Cohesionless Soils," by John Watson (Harvard University); "Work of the A. S. T. M. Subcommittee on Shearing Resistance," by F. J. Converse (California Institute of Technology).

During the year the committee issued a Soil Mechanics News-Letter for the benefit of teachers. Five issues of about 145 copies each contained a total of 23 pages of mimeographed material and were mailed during the first six months of 1939. Subscriptions of fifty cents each contributed to the self support of the Soil Mechanics News-Letter. The main emphasis in these news letters was on library material, and the last four issues were devoted to bibliographies of soil mechanics. News items of interest to teachers of soil mechanics were noted and there was some discussion of the topic "The Place of Soil Mechanics in the Undergraduate Curriculum."

8. *Surveying and Geodesy.*—O. S. Zelner, Chairman. Three papers and one written discussion were presented: "A Brief History of Surveying," by W. H. Rayner (University of Illinois), was read by Paul P. Rice (Lafayette College); "The Principal Use of State Systems of Plane Coördinates," by Philip Kissam (Princeton University), read by George Harding (University of Louis-

ville). A discussion of this paper by John S. Dodds (Iowa State College) was entitled "A Practical Application of Plane Coördinates." "Plans for Future Programs in Surveying and Geodesy" were presented by D. S. Trowbridge (New York University).

During the year the Committee sponsored two regional conferences on surveying and geodesy. The Third Regional Conference was held April 6–8, 1939, at Missouri School of Mines, under the general chairmanship of E. W. Carleton (Rolla). The total registration, 109, included members and guests representing 13 universities and colleges, seven branches of state and federal surveys, three technical magazines, five makers of surveying instruments, and one independent aerial mapping company.

The Fourth Regional Conference was held September 6–9, 1939, at Georgia Institute of Technology, under the general chairmanship of Ralph Black (Georgia Institute of Technology). F. C. Snow (Georgia Institute of Technology) was chairman of the program committee. The total registration, 49, represented 16 universities and colleges, four branches of state and federal surveys, six consulting engineers and mappers, two makers of surveying instruments, and six branches of state and federal administration.

9. *Young Men's Forum.*—Harold C. Bird (Duke University) Chairman. L. E. Conrad (Kansas State College) presided at the second annual Young Men's Forum sponsored as a part of the Division program. The Forum was initiated at the College Station, Texas, conference to give young instructors a definite place where they could be free to discuss matters of direct interest to younger teachers. Teaching methods and course content have been discussed—and so have such topics as serving as machinist for the department, keeping the laboratory in good shape, serving as errand boy, typist, grader, etc.

Three papers were presented: "Mechanical Service in Engineering Laboratories," by G. Brooks Earnest (Case School of Applied Science); "Should Moment Distribution be Taught to Undergraduates," by Stanley H. Fillion (Worcester Polytechnic Institute); and "An Instructor Looks at Teaching," by Roland H. Trathen (Rensselaer Polytechnic Institute).

# CONFLICTING VIEWS ON THE DEFINITION OF ENGINEERING ECONOMY *

By EDMUND D. AYRES

Associate Professor of Engineering Economics, The University of Wisconsin

SYNOPSIS

The apparent conflict of views on the definition of engineering economy is not a conflict of views on definition at all but a difference of opinion on the delineation of explicit boundaries for the subject. The conflict of views with respect to boundaries is also entirely confined to the sphere of engineering education. Engineering economy as a phase of engineering is accepted in engineering practice as a distinct name for the specifically advantageous use of dollars and cents in engineering works. The conflicts that exist with respect to the term engineering economy arise largely out of the fact that the well meaning friends of this subject involved in engineering education are by and large also connected with and enthusiastically advancing endeavors of a broader scope in the field of engineering education such as industrial engineering, management engineering, engineering economics and other subjects, courses, curricula or departments bearing related names.

The optimistic view holds that engineering economy as an engineering subject is so well established in engineering education that conflicting views with respect to the boundaries of the subject are a natural consequence holding little or no threat of permanent harm to the advance of the subject in engineering education.

The pessimistic view holds that the confusions generated by conflicts of view, be it over definition or boundary, are in themselves dire threats to the future advancement of the subject in engineering education and a united effort by the friends of the subject to eliminate looseness in the use of terms and to emphasize the engineering character of the subject is essential.

Undoubtedly the real state of affairs lies somewhere between these extreme views and a reasonable attitude of insistence upon the true meaning of the term in attempts to advance this work in education is of great importance but complete isolation of the term from all contaminating contacts is neither possible nor desirable in the long run.

* Presented at the 47th Annual Meeting, S. P. E. E. (Engineering Economy), Pennsylvania State College, June 19–23, 1939.

## Intrinsic Meanings and Boundary Lines

The emergence of any body of principles and concepts into a new importance brings with it boundary troubles. The separation of civil engineering from its military engineering parent and the weaning of electrical engineering from its parent physics have not resulted in explicit boundaries which the engineer even today could lay out with precision and any great degree of finality. Similarly neither is it possible nor desirable to lay down rigid boundaries for the field of engineering economy. Nevertheless engineering economy as a term must have such intrinsic meaning that its field is definitely recognizable else it can scarcely be considered to command a field at all. Conflicting views do not arise from a general disagreement regarding basic intrinsic meaning—they arise from the general inclination of those who are most concerned to seek intermarriage of the term engineering economy with such suitors as management and political economy. The mingling of the territories of these wedded pairs and the naming of the offspring, to say nothing of delineating the fields to be inherited by the children of these unions, will continue to give rise to baffling confusion until the results of such marriages show such strength as to demand recognition for some term which has earned its right to command a field of work by reason of that strength. Thus at least three factors are involved in any real settlement of the definition of any term pertaining to a field of work—intrinsic meaning, strength through recognition and for want of a better name a factor which in deference to Professor Grant might be called "Humpty-Dumpty-ism."

## Intrinsic Meaning of the Term Engineering Economy

The author believes that engineering economy is definitely a part of engineering—it is that vital part of engineering practice which has to do with the dollar and cents desirabilities of engineering procedures in practice. The intrinsic meaning of the term is clear. The basic differences between the words "economy" and "economics" were carefully explained by D. C. Jackson in the March 1938 Engineering Economy Page of the Journal. In a strict technical sense he established by this explanation a definition of engineering economy which must read approximately thus:

> Engineering economy is that phase of engineering which pertains to the specifically advantageous use of dollars and cents in engineering works.

Thus the term engineering economy can be quite explicitly defined and its definition leaves no room for confusion with other terms.

## Engineering Economy a Term of Recognized Strength

Among practicing engineers, particularly civil engineers, whose work involves constant struggles with cost considerations, the term engineering economy has a distinct meaning. Although the author has no results from a survey to prove such a statement he is confident that the practicing engineer would pick out engineering economy every time as the term most appropriate to describe the "will it pay" studies and cost applications of his every day engineering.

In engineering education comes the disturbing confusion of terms because engineering economy is often associated with educational endeavors called by various names such as engineering economics, engineering administration, industrial engineering, administrative engineering, and management engineering. The teachers who are most interested in engineering economy are often connected with courses, curricula and departments whose content or sphere of interest extends beyond the strictly engineering subject of engineering economy. It is by association with these educational variations particularly in connection with courses and curricula including work in political economy, business administration and management that engineering economy is threatened with submergence, not because of lack of intrinsic meaning but because the majority of those most active in extending the influence of engineering economy are also hard at work in extending engineering education into the fields of finance, economics and management. Their enthusiasms often carry discussions and even deliberations foreign to the real work of engineering economy into the committee work carried on in the interests of and under the name of engineering economy. Practically it probably is both impossible and undesirable to eliminate such activity. Whatever danger exists in these close associations of engineering economy with work reaching out even beyond the true realms of engineering is more than compensated for in the support which engineering economy as a fundamental engineering subject receives from these same men.

In engineering education engineering economy has attained a real importance. The work of Professors Fish and Grant in particular has made possible the belated recognition which engineering education is now giving to this work. Its claim to importance rests upon its unquestionable significance in engineering. Its inclusion in many engineering curricula has largely awaited its better organization for teaching purposes. This latter achievement is largely responsible for the natural success and warm recognition it is obtaining to a gratifying extent in engineering education. It seems certain that engineering economy as a distinct subject has

attained a rather considerable strength and a rather wide recognition in engineering education. This strength linked with its recognition in engineering practice seems important enough to warrant its survival from any amount of association with any of the broader endeavors in engineering education.

In spite of this confidence which the writer has in the ultimate survival of engineering economy as a true engineering subject, it seems certain that the careful definition of the work and a definite attitude conducive to its recognition as a subject apart, is a prime requisite for the advancement of its future importance in engineering education. This means that work carried out under the title of engineering economy should not necessarily shut out all associated work but should always as far as possible deal predominantly in the field which all recognize as well within the territory which this subject commands. The many undeveloped areas of the work and the much needed scrutiny and review of particular applications falling directly within the highly developed areas of engineering economy would seemingly afford much material for discussion and deliberation for years to come.

## Humpty-Dumpty-ism with Regard to Engineering Economy

In the March 1937 Engineering Economy Page Professor E. L. Grant invoked Humpty Dumpty out of Lewis Carroll's "Through the Looking Glass' as the philosopher with which those who wish more liberal interpretations of the term engineering economy might conjure.

"When I use a word" Humpty-Dumpty said, in rather scornful tone, "it means just what I choose it to mean—neither more nor less."

"The question is," said Alice, "whether you can make words mean so many different things."

"The question is," said Humpty-Dumpty, "which is to be master—that's all."

Conflicting views on a definition for engineering economy undoubtedly pivot upon a certain amount of Humpty-Dumpty-ism in general usage and not at all upon any disagreement as to the basic sense of the term as rigidly defined. The Humpty-Dumpty-ism in general usage affects the matter of boundaries for the subject of engineering economy—probably no amount of re-definition could ever change the intrinsic meaning of the term but a concerted effort on the part of engineering educators might well in time permit the expansion of the scope of the subject to include much that seems more properly now included under the broader terms listed before. The desire on the part of most of these educators to advance the im-

portance of other terms may well result in the inclusion of engineering economy as a subject to be embraced in the concepts of engineering economics or engineering administration or in the meanings of other terms, but the sheer diversity of these concepts and the devotion of these teachers to particular terms seems certain to protect ultimately the term engineering economy from gathering too much disputed territory for itself. Humpty-Dumpty-ism probably represents a force of little importance in the present conflict of views on definition and a force practically negligible with respect also to boundary delineation because of the extreme unlikelihood of agreement among interested engineering educators to extend the scope of engineering economy as a term.

## Relation of Engineering Economy to Engineering Economics

The terms engineering administration, management engineering, administrative engineering and industrial engineering all have certain recognizable flavors in their names which at least afford some basis for assuming fairly accurately what relation they may have to the subject of engineering economy. Engineering economics, on the other hand, is a relatively new term which bristles with possibilities of confusion between the words "economy" and "economics." It is believed that a very satisfactory distinction between these two words has already been given to us by D. C. Jackson. Reference to his statement of this matter has been given in the above paragraphs. What is more important is the significance of engineering economics in its actual use as a name for departments, curricula or special work in some quarters of engineering education. A statement made by Professor Peterson of New York University in a letter to Professor Grant comes as near to defining engineering economics as a term and pointing out to all the hopes of those connected with work carried out under this name as probably will be found:

> I am thereby leading to the suggestion that we face a larger basic professional field properly called Engineering Economics, that should be kept rigidly within professional bounds, covering the econometric aspects of engineering "in all phases of planning, production, construction, distribution and utilization." This larger engineering responsibility in economics may be an important professional answer to the critics of management in engineering, where so much of the original scientific concepts seem to have been diluted with commercial techniques and arbitrary management philosophies. From this parent subject would stem not only the Engineering Economy "of selections and replacements of technical alternatives," but also the Economics of Industrial Enterprise, Engineering Statistical Analysis, Evaluations, and similar fundamental professional applications within the above indicated bounds.

Thus engineering economy is set forth as being of basic importance in engineering economics but it is also recognized as a distinct subject among others which together comprise a broader concept than is afforded by the term engineering economy alone. Practically there would seem to be no real basis for confusion between the terms.

## Another View

The above paragraphs have attempted an analysis of the situations and forces making for confusion in the definition and use of the term engineering economy. This analysis and the conclusions offered are definitely optimistic regarding the present importance attained by engineering economy as a subject. No real measure of this importance has been attempted to support the claims of strength intimated. Could it be that the recognition of engineering economy as an engineering subject by engineering educators in general has been over-estimated? The remarks of Professor Adams of the University of Utah in the September 1938 issue of the Engineering Economy Page would indicate that the Engineers' Council for Professional Development has not afforded it the recognition that it deserves. Even though the combinations in which E. C. P. D. may have found engineering economy involved as a subject may have had much to do with its attitude toward the subject in specific cases, it might be wise for the friends of engineering economy to look at the matter pessimistically and, not only to defend jealously engineering economy from all confusions with other terms, but to unite for the purpose of striving vigorously for the advancement of this sorely needed subject in engineering education.

# POPULARIZING RESEARCH *

By WATSON DAVIS

Director of Science Service, Washington, D. C.

Engineers and scientists are realizing more and more that it is important and proper to take the public into their confidence about the research that they do. Today the "public be damned" attitude has been largely replaced by the feeling that the public should be informed.

In the past two decades the interpretation of science to the general public has made large strides, due to the fact that both those who create new knowledge and those who relay it to the public have come to appreciate the necessity of coöperating in order that the public may know what is happening and may benefit through that knowledge.

Taking the public into our confidence is often somewhat of a nuisance as far as scientific and engineering work is concerned. The scientist in his laboratory does not wish to be bothered with the unskilled questions of casual visitors. The astronomer looking at the heavens through a large telescope at new stellar universes very distant from the earth hardly has time or the desire to bother with pointing out the planets to sight seers. The engineer superintending and planning the construction of a skyscraper is often troubled by the dozens of passersby who like to see a steam shovel at work.

Yet, in our public relations we can most effectively utilize the spirit of the "sidewalk superintendents' clubs" that have blossomed at building operations in large cities recently. Very cleverly and with an appreciation of the public interest, the construction companies responsible at several large operations have made parts of the wooden platforms around excavations observation points for the public, labelling them in such a way that the public is cordially invited to look and learn. This to my mind is a very progressive step in taking the public into the confidence of engineers. I would suggest that in addition to allowing them just to see what is going on, which is the rather mechanical part of building construction, there be placed exhibits of drawings, blueprints and other material so important to building construction. This would get across the

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idea that it is not alone the steam shovel and the dirt trucks that make a skyscraper possible. They will realize that even though they may not have the opportunity of seeing the engineer at work he is important in the building of our modern city. They may even get the idea that the engineer is not the fellow who operates the steam shovel but is a professional man to be thought of in the same category as a doctor or lawyer.

We as engineers are concerned largely with doing our job. Too often we take ideals, philosophies and modes of action for granted. We are like the chemist who is far more concerned with making a product than whether it will be used for good or evil, for peace or war.

Nevertheless, the ideal, the philosophy, the brand of thinking is so important and motivating that it transcends the material deed. This is not because the deed is not necessary, for we can not live on ideas alone, but because the intellectual and emotional drive has the power of catalyzing the creation of material things.

The reason we take engineering and science to the people, as I see it, is because we are convinced that it is the successful method of doing and thinking. Much of our battle upward is a conflict between science and superstition. It is astronomy *vs.* astrology, fact *vs.* hearsay, experiment *vs.* dogma, scientific agriculture *vs.* planting by the light of the moon, planning *vs.* trusting to luck.

In these perilous times for so many areas of the world, we can not reaffirm too often that the scientific way is the democratic way. The methods of science will make democracy work if they find their way to the public. Test of reason and experience can weed out the charlatan, the incompetent and the unworthy in high and low places in our people's business, if we see to it that democracy is free to operate. Freedom to practice the scientific method in the everyday world as well as in the laboratory is of importance equal to freedom of the press and assembly.

When we see the cramming of thoughts into dictator-wrought molds, the exiling of the brains and bodies of the human cream of great nations, the suppression of even the hollow shell of freedom over great areas of this earth, we are thankful for the conditions under which we live and which we are resolved to maintain.

Horrible is the fact that millions have died in our current wars. Bombings of innocents that would have had foot high headlines in another decade now hardly make the first page. The destruction of lives, cities and fields is a great tragedy, but more dangerous to the future of our civilization are the throttling of ideas, the suppression of facts and the sterilization of intelligence.

These observations may be considered of no immediate application to the task of informing the public as to what happens in our

engineering and other research laboratories and what it means to them. But I do not believe so. Along with giving technical and engineering information to the public, it is our duty to give the average person the opportunity of being an informed, rational and concerned unit in our democracy. Unfortunately, this can not be done effectively by using the abstract terms that have been used in the preceding paragraphs. An intelligent, emotional appeal must be used if the mode of thinking and doing on the part of the average person is to be influenced.

Since 1921, I have had the great good fortune to play a part in the development of the interpretation of science to the public through Science Service, the institution for the popularization of science, whose Trustees are nominated in part by the National Academy of Sciences, the National Research Council and the American Association for the Advancement of Science. Science Service was charged with injecting science, both its informational content and its method, into the daily life of the people through newspapers, magazines, the radio and any other available channels.

We have found that there are emotional words and ideas that can be utilized in making a technical story good currency for use by such a medium as the newspaper. Any story that has cancer, war, gold, sex and other such emotional ideas in it is likely to get used by a newspaper.

In the field of engineering, key words of emotional appeal include such terms as power, biggest, less expensive, more useful, safer, etc.

Very often an important piece of engineering information can be placed in the press because it can be linked with one of these more emotional ideas. And in most cases, this linkage can be made quite proper and legitimate.

If you dig deep enough, you can make practically any engineering research or construction story an extremely interesting one. It may be a success story. It may be a detective story. It may be a mystery story. It may be a story with a big name in it. It may even be what might be called a "high hat" story, or it may have a touch of humor.

Much as we would like to be able to write a formula for a good story for the press upon a technical subject, it is hardly possible to do so with the accuracy with which an iron girder is designed. There is still a considerable amount of art as well as science in this matter of technical publicity.

There are, however, many devices that can be used in technical publicity and information activities that can be to some extent put into formulae. Take this meeting of the Society for the Promotion of Engineering Education. So far as I have been able to discover,

there is no press room and no facilities available for feeding the more important of the papers delivered here to the widespread press of the country. From looking over the program, I am quite confident that you have a very interesting lot of papers many of of which would undoubtedly make good news stories in not only the large cities of the country but in the small towns, particularly those towns from which the speakers come, or in which are located engineering industries or educational institutions.

It would be relatively simple to have someone bring together in advance of the meeting copies, or at least excerpts from some of the most important and most newsworthy papers. It would mean coordination with the secretary's office and some planning but that would not be difficult. Since this is a really important national meeting, I think it would be quite possible to have the leading press associations of the country and perhaps some of the leading metropolitan newspapers give it the sort of coverage that they give to other meetings of equal or less importance.

The planning of a meeting might even be done with publicity in mind to some extent. In coöperation with the secretary, the person handling publicity might see to it that there is on the program one news event worthy to appear in the morning and evening papers of each day of the meeting. As a matter of fact, if there are two or three good papers per day that would in most cases furnish ample grist for the news mill. It is not even necessary to have the reporters in attendance at the meeting although that would be desirable. A great deal can be accomplished by placing pregathered abstracts and copies of the papers in the hands of the people who write for press associations and the larger newspapers.

The element of competition in connection with the reporting of scientific meetings should not be overlooked. If you can get one press association to give your meeting adequate coverage, you may be sure that there will arise a competitive demand for similar coverage on the part of the other press associations.

This is undoubtedly very elementary to those of you who have carried on engineering publicity successfully. The same principles that I have been talking about in connection with this meeting can be applied to your institutional publicity throughout the year.

In these days, I am sure that you will find all the newspapers in your vicinity, the technical press and the national news gathering organizations eager to coöoperate with you to the fullest extent possible. You will find newspaper editors and reporters highly desirous of having their technical and scientific material accurate as well as interesting. This may not have been the case at one time but times have changed.

On behalf of Science Service, I want to ask your coöperation in sending us information about the progress of your various engineering researches from time to time. We are eager to coöperate with you because we know that the research that you are doing is of great importance not only to the localities and institutions with which you are connected but to the country and the world at large.

In the larger sense, research in science and engineering is undertaken for the advancement of the human race. Research is done with the ultimate goal of making the world a better place to live in. The same high motives run through the increasingly more effective interpretation of science which is being accomplished through the coöperation of the technical man, the press and the public.

Nevertheless, it should not be overlooked that interpretation of science and technology to the public, speaking in terms of the industrial world, is good business. If there were no other justification for it, this would be justification enough. If you can explain to the public why you are doing engineering research, the public will understand and appreciate and, what is also important, it will provide the money which allows you to carry on your researches to add to the knowledge of engineering art and science. So, if there is hesitation on the part of your colleagues at the idea of intensified informational activity, perhaps you can suggest to them that in publicity they and the work that they do have a rather large financial stake. And often because the world is so constituted in many respects, this type of argument may be more effective than the more important and altruistic goal of serving the general good more effectively.

# THE EFFECT OF THE TENDENCY TO REDUCE ENGINEERING DRAWING TIME *

By A. S. LEVENS

Assistant Professor of Drawing and Descriptive Geometry, University of Minnesota

During the last decade, perhaps during the past twenty years, many of us have been deeply concerned over the "Tendency to Reduce Drawing Time." We are aware of the important part that engineering drawing plays in everyday planning. The application of the graphic language to the development of engineering projects is a well-known fact. Time and time again it has been pointed out that the construction of buildings, roads, bridges, dams, etc., all require planning—yes, planning on paper first. The design of equipment, the design and manufacture of the automobile, of the aeroplane, of the rolling stock of our railroads, the effective planning of the home, all require use of the graphic language—one of the engineer's most vital tools.

Surely, those engaged in giving drawing instruction to the engineering student recognize these facts. Surely, those engaged in teaching the so-called professional courses of the various branches of engineering are fully aware of these facts. They might be duly impressed by the development of graphics and its application to engineering. The history of graphics is most fascinating. We might point out its growth from the days of the early crude pictograms, and ideographs, to the semi-scientific approach of Frontinus in the preparation of plans for the Roman aqueducts; to the work of Leonardo da Vinci; to the work of Gaspard Monge and his remarkable pioneering in descriptive geometry; and to many others in addition to the fine work of writers during the last 30 years. Professor Higbee did a complete job in his paper, "History of the Development of Graphical Representation," delivered at the Engineering Drawing Summer Session at Carnegie Institute of Technology, in June, 1930.

Unfortunately not many read this type of information. The members of degree-giving departments, naturally, are biased toward

* Paper read at the S. P. E. E., Drawing Division Conference, Pennsylvania State College, June, 1939, and recommended that: (*a*) The paper be printed in the JOURNAL as the outstanding paper of the conference; and (*b*) that this motion be appended, and copies be placed in the hands of all deans of engineering colleges.

the development of their own course work; toward the introduction of new courses which they feel are necessary to keep abreast of the progress being made in their respective fields. A difficulty arises. "How can they include these new developments in an already crowded four-year curriculum?" Sometimes this question is answered by reducing the time which is available for drawing. Again others find it necessary to reduce the number of electives. Some solve the problem by offering work in the graduate school. I do not wish to open the question of curriculum-building at this time.

We who are devoting our teaching to the development of young men seeking training in engineering drawing are not pleased with the encroachment on drawing time. During the past several weeks, a study was made to determine how serious this encroachment has been. Questionnaires were sent to the drawing departments of 80 engineering schools. Of this number, 48 or 60 per cent replied. The following questions were included:

I. How many students are enrolled for the required first year engineering drawing courses? .....

(*a*) How many hours per week under supervision .....

(*b*) How many hours per week not under supervision? .....

II. How many students are enrolled for required sophomore engineering drawing courses? .....

(*a*) How many hours per week under supervision? .....

(*b*) How many hours per week not under supervision? .....

III. To what extent have you experienced a decrease in the time allotted to drawing during the last twenty years? .....

IV. Do you believe that the time now available for drawing instruction is adequate for the proper development of technique and fundamentals? .....

V. To what extent do you believe drawing instruction should be increased? .....

VI. To what extent does your drawing department offer any graduate work in the field of engineering graphics? .....

Based upon the collected data the following facts are revealed:

1. The total number of students in first year drawing courses varies from 60 to 1266 (Year 1938–39). Twenty-nine schools have from 60 to 300 students; 10 from 300 to 600; 9 above 600.

2. The average number of supervised hours devoted to freshman drawing courses is 6.4 per week. Seven schools ranged from 3 to 5 hours per week.

3. The average number of non-supervised hours devoted to freshman drawing is 1.3 (for all); 23 schools or 48 per cent of the number replying required non-supervised time. Most of the others,

15 schools, indicated no outside work beyond that required for reading of text material.

4. The number of schools offering sophomore courses is 31 or 64.5 per cent of the total.

5. The average number of supervised hours devoted to sophomore drawing is 4.8 per week. Hours not supervised average 0.8 per week.

6. The total number of students in sophomore drawing courses varies from 7 to 306 with Purdue having 800.

7. Twenty-seven schools, or 56 per cent, experienced a decrease in drawing time during the last two decades. Nineteen schools experienced no decrease, and two had their drawing time increased. In one case the increase consisted of a recitation hour in the freshman year and the addition of three laboratory hours in the sophomore year, bringing the total to six laboratory hours plus one recitation hour, for freshman work, and a total of seven hours for sophomore work. In the second case, the increase was 50 per cent which resulted in five laboratory hours plus one hour of home work for freshman, and four laboratory hours plus two hours of home work for sophomore drawing.

8. Decrease in drawing time varies from 0 per cent to 100 per cent. *The average decrease is 30 per cent.*

9. *Twenty-six schools, 54 per cent, believe the time now available for drawing is not adequate for proper training in fundamentals and technique.* These schools average five hours per week for freshman drawing and three hours per week for sophomore drawing.

10. Eleven schools, 23 per cent, believe the time now available for drawing is adequate. *These schools average 6 hours per week for freshman work, and 6 hours per week for sophomore work.*

11. Six schools, 12.5 per cent, believe the time now available is adequate for the better student, but not for the poorer student.

12. Five schools, 10.5 per cent, did not answer the question or were not sure.

13. *The number of schools desiring an increase in drawing time is 27, or 56 per cent.* The amount of increase desired varies from 10 per cent to 100 per cent, with an average of 40 per cent.

14. The number of schools offering some graduate work in graphics is 5. Forty-three schools, very nearly 90 per cent, offer no graduate work in graphics. Only one school has a program which will lead to the Master's degree. Approval of the Master's degree in graphics is expected within the next year.

A recent study made by H. C. Spencer showed the average number of clock hours devoted to engineering drawing and descriptive geometry at the present time is 374. This was based upon returns from 58 schools. It should be noted that the number of

hours, 374, includes all required drawing given in both the freshman and sophomore years, or at other levels. This is equivalent to a full time period of somewhat over 9 weeks, based upon a 40 hour week. Twenty-four schools, or 41 per cent, offer more work, the average of which is 507 clock hours. Thirty-two schools, or 55 per cent, offer less, the average being 275 clock hours; 2 schools offer 374 hours. The average number of clock hours devoted to engineering drawing is 214. Forty-one per cent of the number replying offer more time, the average being 306. Fifty-nine per cent offer less time, the average being 145 hours.

In descriptive geometry, the survey discloses an average of 157 hours—the equivalent of approximately 4 weeks full time. Thirty-seven per cent offer more time, the average being 232 hours. Sixty-three per cent offer less time, the average being 109 hours—approximately 2 weeks and 4 days of full time work.

Let us return to interesting comments which were made in connection with the questionnaire mentioned before.

15. One professor stated, "Reduction in drawing time made it necessary for us to re-design our courses and also our methods of instruction. We are teaching more drawing now (6 hours/week) than when we had a 9-hour time allotment."

Another stated: "We have been successful in making some addition to our freshman training by the adoption of a course in graphical representations and pictorial drawing, elective in the sophomore, junior, and senior years. Many students are availing themselves of this privilege."

Still another stated: "For average use of drawing we now have enough time. To turn out finished draftsmen, we should double the time."

From one of the smaller schools the comment was: "Unfortunately the better work we do in engineering drawing, the more pressure we experience to decrease the amount of time allotted to drawing."

*Another comment from a big ten school was: "Those engaged in teaching drawing should sell the importance of their subject to the administration. They do not need to sell it to industry."*

From a southern school: "I think nine hours per week the first year and six hours per week the second year would be satisfactory."

Another: "We should have not less than 9 lab hours for drawing proper, 1st and 2d semester, plus not less than 9 lab hours in Descriptive Geometry in the second year perhaps, with not less than 6 hours of specialized drawing in the second semester of the second year." He also states: "In a recent discussion of the failings of engineering students, Dr. Rippie who was addressing the Missouri Branch of S. P. E. E. *opened his discussion* by stating that in his

opinion *chemical engineers are being deplorably under-trained in engineering drawing,* with the result that numbers of them who in recent years have tried to record their ideas for patent purposes *did so in such wretched fashion that they utterly failed to properly bring out the particular features of processes they were trying to patent,* with the result that *competitors edged in and wrested away the ideas sought to be patented.* He extended this comment to cover also the training in English."

Fron another: "Would increase freshman time so as to include more sketching and charts, nomographs, etc.; and more sophomore time for development of machine drawing."

From an outstanding author, T. E. French: *"In many colleges the drawing given is pitifully inadequate."* Referring to his own school he stated: "The largest decrease was in the electrical engineering course which cut out all the sophomore drawing a few years ago. The mechanicals cut one quarter and left one. The industrials and chemicals seem to appreciate more the value of drawing in their courses. The course required in the senior year in chemical engineering is particularly appreciated.

"This year a committee was appointed in the engineering college to study and report on the proposition of decreasing the time given to drawing and it is interesting to note that while statistics showed that we were giving more time to the subject than were many other colleges, the report recommended that no decrease be made." This is indeed encouraging since it tends to show that the pendulum is beginning to swing the other way.

What does industry think of the training our young men receive in *graphics?* Permit me to repeat a few facts which were disclosed in the study made in 1936.*

1. Seventy-four per cent of our young engineering draftsmen do not make a clear-cut drawing.

2. Seventy-five and three-tenth per cent are not capable of making a fairly complicated drawing.

3. Seventy-six and two-tenth per cent of the number of companies that answered the 1936 questionnaire believed that one year of drawing (250 to 300 hours) is not sufficient.

4. Eighty and five-tenth per cent believed that drawing instruction over a two-year or longer period is desirable.

May I burden you with a repetition of two comments which were quite significant: 1. "The particular deficiencies of those having drafting training, whether it be at college or schools for drafting alone, are that the students do not appreciate sufficiently that the day of artistic drawing is passed. What we require today is

* "What Training in Graphics does Industry Require of the Young Engineer?" JOURNAL OF ENGINEERING EDUCATION, May, 1937.

legibility and a full appreciation that the drawing is to be used by a mechanic who has no other information. The vagueness of the drawing includes the draftsman's unfamiliarity with the tooling facilities involving economies with the equipment available; the proper views and sections for rapid and correct interpretation, and most importantly the location and method of giving dimensions which also is governed by the planned machining process. *My opinion of a good drawing is not one that can be understood, but preferably one that cannot be misunderstood.*"

2. "I wish to comment that in general the engineering graduate does not look favorably on entering industry to work on the drawing board. I think more emphasis should be used in the training to make him appreciate that the drawing board is the place where the best and most efficient designing can be carried on. The trend in industry is such that drawings play a very important part in the planning of economical manufacture in all its phases. Obviously the design itself and the dimensions on the drawings must be sufficient so that they will fit in to the best advantage with the manufacturing conditions, tools available and desirable at the place where the apparatus is to be manufactured."

The article* by H. C. Brown includes data which corroborate these facts. It is pointed out that many of the faults of the young technical graduate include:

1. A lack of interest in drafting.
2. A lack of proper instruction concerning drafting
3. An over-estimation of his importance and value.
4. Inaccurate work.
5. Lack of patience, lack of ability to be neat, lack of imagination, and lack of ability to visualize and concentrate.

In view of the evidence presented, what can we as drawing teachers do to further impress administrators, engineering educators, faculty members of professional departments, and interested alumni that it is a step in the wrong direction to reduce the time allotted to engineering drawing and descriptive geometry? What can we do to get our story across to those who took drawing twenty-five or more years ago that many changes have taken place—that the days of drafting as a technique alone—the period of drafting as an art only—have gone by; that today much to the surprise of many a graduate—descriptive geometry is really useful and plays an important rôle in the graphical solution of engineering problems?

What can we do to inform leaders in engineering who profess to have a knowledge of drawing; who in one breath state: "The

* See T-Square Page, March 1939 issue of the JOURNAL OF ENGINEERING EDUCATION.

teaching of useless or idle subjects should be eliminated. Such unenlightening disciplines as descriptive geometry are outworn and should at once be discarded"; then in the next breath, "The major departments of teaching are three. First is training in the use of essential craft tools, such as measuring, *drawing*, writing, bookkeeping. Second comes study of the fundamental sciences. Third is training in engineering procedure. The last would supply the training that is most seriously lacking in the young engineer, namely, the power and habit of outlining a required course of investigation, finding and assembling the necessary facts, marshalling these in calculation, design or conclusion, and arriving at the complete solution of the problem or else defining the limits of practicable solution."

Oh, what a pity that these leaders, and also some members of degree-giving departments, fail to recognize that a fundamental training in descriptive geometry—as taught today—thanks to such writers as Smith, Hood, Warner and the recent excellent work of Higbee—is essential to the development of these qualities in our young engineers. Oh, what a pity that these men do not return to their colleges to learn of the progress that has been made in descriptive geometry. I believe they would be enlightened—and frankly, they need a lot of it.

Gentlemen, we are faced with the problem of completely curtailing the tendency to reduce drawing time. What can we do? May I offer a few suggestions, several of which have been in practice?

1. Our present courses in engineering drawing and descriptive geometry should be carefully reviewed and then modified in a manner which will render the most effective work we are capable of giving. A little house cleaning might disclose a few cob-webs here and there. Professor Higbee's remark is quite significant. He states: "Drawing time should not be increased if drawing departments do not make better use of the time they now have."

Sectional, regional and national S. P. E. E. meetings provide an opportunity for an exchange of ideas from which we can develop our work to a maximum of efficiency.

2. We should coöperate most fully with the degree-giving departments. Let them know what we are including in course work. Suggestions for changes should be carefully studied.

Professor Miller of the University of Michigan has introduced a coöperative program with the degree-giving departments which is worthy of your consideration. He remarks: "We have now assigned our men in pairs to examine the drawing work done in professional departments and to coöperate with instructors of such departments in their drafting problems. We have come to the con-

clusion that the knocking about Math, Physics, English, Drawing, etc., is the result of lack of inclination on the part of instructors in professional departments to keep the students on the alert in these subjects. They have assumed permanent inoculation. So we have reversed the offensive and believe it works."

3. We should acquaint our faculties with the standards of work we require of our students in drawing. Frequently, if not usually, the drawings accepted by the professional departments would not receive credit from a drawing teacher.

Drawings should be on display at all times—in a place where they can be seen by administrators, faculty members, students, and visitors. Frankly, I believe, this will bring about an interest in our work—and what is more—awaken those who have a silly notion that an engineering draftsman is a "pencil-pusher." They, for the first time, may recognize that clear thinking, careful planning, good technique, an understanding of the principles of projection, and a working knowledge of the methods and processes used in present day manufacturing and construction are the qualifications of the engineering draftsman. They, for the first time, may recognize engineering drawing cannot be taught by anyone. It may be news to them that the successful drawing teacher, in addition to an engineering training, has practical experience; that he has the patience to work with young students; that he has the personality with which to inspire the embryo engineers; to instill in them the spirit of engineering; and to help them develop desirable traits—punctuality, resourcefulness, initiative, and the ability to work with others—traits which the prospective employer seeks in our graduates, and which he usually values as much as scholastic attainment.

It should not be forgotten that many engineering graduates enter professional work through drafting. The graduate need not fear that, because he is a good draftsman, he will be kept at that work indefinitely. To quote from one of the remarks in the 1936 survey: "There has been an idea prevalent among many of our young engineers that if they made a first class drawing they were likely to be sidetracked and never get more advanced work. To me, a clean cut drawing indicates that the man should be considered for advancement ahead of a careless worker."

Furthermore the successful professional engineer must have the ability to read a drawing; to convey his three dimensional concepts to the young engineer who can use the graphic language to develop the mature engineer's ideas.

Recently, C. R. Soderberg, Professor of Applied Mechanics at Massachusetts Institute of Technology, stated: "Industrial drafting work involves essentially two phases: 1. The technique of making legible and clear drawings which, in your own words, 'cannot

be misunderstood.' This involves a certain degree of artistic skill, but particularly training in perspective geometry.

"All engineers, whether they work as draftsmen or not, require a well developed sense of coördinating conventional pictures with the actual space configurations.

"2. Experience and training in design, that is, the functioning of the apparatus, familiarity with the different possibilities of manufacturing, material properties, shipping limitations, etc.

"It is my firm belief that the college training must develop the first of these two phases. Moreover, I feel that this training is as essential to the designing engineer as to the draftsman himself. Our engineering schools do not now give adequate training in this respect."

And what of the 40 per cent to 50 per cent of entering freshmen who never graduate? What can they do if they drop out of school at the end of the sophomore year? What good has the training they received done them? What courses other than drawing give them a fair chance to enter the engineering field?

4. We should coöperate more fully with industry. It is essential that we become acquainted with their problems; that we have a clearer understanding of the progress made in the industries. True, we can do this, to some extent, through reading and visits to their plants. A more effective way would be through summer employment. There are concerns that have expressed a willingness to employ a few drawing teachers each summer. In that manner, over a period of years, many instructors will have desirable contacts with industry—contacts which will give them added experience, thus keeping them abreast of the times. This should lead to more effective teaching.

5. Every effort should be made to introduce graduate work in the field of graphics. Administrators require the Master's degree of candidates for teaching positions. In many cases the Ph.D. degree is necessary. Whether or not we agree with this practice is not important at the moment. There are many pros and cons that can be presented. Nevertheless, the fact remains that it is becoming more difficult to obtain teaching positions without the Master's degree. What is more, it is likewise becoming difficult to obtain promotions without advanced degrees. Why not set up a committee to study the problem of working out a program, the satisfactory completion of which will lead to a Master's degree in Graphics? Some progress has been made. I believe the time is ripe for a step forward.

To recapitulate: The solution of our problem appears to lie in a concentrated effort to accomplish the following:

1. To take inventory of ourselves and our courses in order to eliminate any inherent weaknesses.
2. To coöperate fully with other departments in our engineering schools.
3. To properly and effectively display the work of our drawing students.
4. To keep actively in touch with industry in so far as possible.
5. To foster programs which will provide for advanced training in graphics.

It is our hope that administrators, and those responsible for curricula building, will carefully review the facts presented; that they will make an effort to become better acquainted with our work. In this way we may look forward to better understanding; to a fuller appreciation of our problems.

# THE USE, CARE AND MAINTENANCE OF LABORATORY INSTRUMENTS

By H. N. HAYWARD

Associate, University of Illinois

The educational electrical laboratory may have as its objective the experimental verification of theoretical truths, the development on the part of students of a familiarity with and a technique of handling circuits and equipment or a search for new or more exact data in the conduct of special studies. With all of these, electrical and other instruments serve as the means of obtaining experimental evidence. If the results are not to be wholly or partially obscured, the accuracy of the data must not only be beyond question but it must be known to be reliable. This requires the availability of accurate instruments, also that their accuracy be maintained and verified in use. Blind faith in the accuracy of the instruments used should have no place, but is often encountered in the experimental laboratory. If the accuracy is to be maintained and known, frequent checking of the test instruments with reliable working standards is essential.

But it is not enough to have instruments of high quality and accuracy available; they must be properly used, although all too often they are not because apparently their limitations are not understood. Positional errors may be important if instruments are used in positions other than intended by the manufacturer. Imperfect balancing of the moving system, change in the friction torque with change in the point of contact between jewels and pivots and the slight displacement of the moving system resulting from the necessary freedom of the pivots in the jewels may all introduce unknown errors if an instrument is not used in the normal position for which it is designed and calibrated.

If possible, the correct type of instrument should be used in every application. Even if shielded types are used, reversed readings should be taken when dynamometer instruments are used on direct current as the shield may become magnetized or may not be fully effective. The effect of wave form and frequency on accuracy should be known where there is a possibility it may be of consequence. With good instruments, the final direction of movement of the pointer before coming to rest should make little difference in a reading. All instruments read low by the frictional error

(which may be quite variable) for increasing deflections and high, by a like amount, for decreasing deflections.

As instruments are usually calibrated "up-scale," that is, for increasing deflections, best results will be obtained when used in the same way. It is considered good practice to tap the instrument top lightly with a finger tip in line with the axis of the movement to minimize the frictional error when taking readings.

Modern instruments are effectively compensated for the usual range of temperatures encountered in practice or are provided with correction formulas. Under extreme conditions, temperature corrections should be made to reduce the error as much as possible. Errors caused by magnetic fields are probably more common and of greater magnitude than may be evident. Often the effect of coils and leakage fields on unshielded instruments is obvious, but the smaller effect on shielded instruments used in important tests may be of more real consequence, although not given consideration. The magnetic field of an adjacent tubular rheostat has been known to introduce serious errors in the reading of a shielded instrument, and tubular rheostats are becoming increasingly popular. Non-inductive tubular rheostats are available, but are much more expensive so are not commonly used.

Aging is another cause of error in some instances, and is one that is often overlooked. It may affect the accuracy by introducing an error that is somewhat proportional to the deflection, or it may change the scale characteristic and cause the error to be irregular over the scale. In this connection, the use of calibration curves might be considered. The total error may be divided into two parts, one that is more or less fixed in proportion to the deflection and another which may vary between established or unknown limits. If the variable error is large with respect to the other, dependence on calibration curves is not justified. If the fixed error is of sufficient magnitude, a calibration curve may be of use if it is applied with the presence of the variable error kept in mind. The best practice would be to repair the instrument to reduce or eliminate the fixed error. The effect of previous overloads, which may not be externally evident, may also cause an instrument to be seriously in error.

How often should instruments be checked or calibrated? Always whenever important tests are to be made, and as often otherwise as good practice and experience indicate is advisable. As a rule, it probably is more satisfactory to set the instrument being calibrated exactly on a main scale division and read the standard to determine the error, as the standard can be read more accurately. Indicating laboratory standards may be used to check and calibrate

test instruments, unless the higher precision obtainable only by a null method is necessary in special instances.

The usual calibration methods are too well known to require detailed explanation here. The first step always should be to examine the instrument carefully to determine if any damage is evident, such as a bent or sticking pointer, making it necessary to repair the instrument before it is calibrated. In most instances, the scale characteristic of an instrument will be similar for all ranges, making it unnecessary to calibrate all ranges of multirange instruments. A complete calibration of one range, with one or a few points checked on other ranges or the measurement of the resistances of the several ranges of potential instruments is all that is needed to complete the calibration for most purposes. A check should be made to determine the magnitude of the frictional error when an instrument is being calibrated.

Iron vane instruments always should be calibrated on alternating current. If dynamometer instruments are calibrated on direct current, a complete set of reversed readings should be taken and the average values used. The "polarity" error may be relatively large and should be eliminated in this way. Wattmeters may be calibrated with separate current and potential circuits, which should be connected at the "low" terminal of the potential circuit to insure that there will be no absolute potential differences between the stationary and moving coils to cause abnormal errors in the readings. All other instruments, such as tachometers and current transformers that are used in connection with the electrical instruments, should be given their share of attention and checked frequently.

It has already been stated that, if an instrument has a relatively large fixed error and proper facilities are available, it is generally more satisfactory to repair the instrument and reduce the error instead of correcting for it by means of a calibration curve. The real value of a calibration curve is doubtful when experience has indicated that it is impossible to reproduce a given calibration curve for any instrument. If used, calibration curves usually are relied upon to justify a degree of accuracy which may be impossible of attainment.

The calibration and checking of instruments should not be limited to old ones. New ones should be examined with care to determine if the stated accuracy requirements are met or if they have been damaged in shipment, as may sometimes occur.

Maintenance of service instruments extends beyond periodic calibration or checking to insure accuracy of results. The case, glass, binding posts, handle and other exterior parts may require repair or replacement from time to time. Binding posts may be burned or

the screw threads wear out, switches wear out or break or require cleaning and connections become loose. Pivots become worn and jewels may crack, springs and resistances may change with age or because of overloads and lint or dirt may cause moving systems to stick. An instrument that is off zero may be found to be damaged by overloading when examined although there is no other external indication of damage.

Instruments are delicate mechanisms, but will withstand a surprising amount of hard service without serious impairment of accuracy before requiring repairs or adjustments. In order to determine how extensively instruments are used and what repairs are most often necessary, a service and repair record system has been developed for use in the Electrical Engineering Department of the University of Illinois. Instruments are requisitioned for use on individual cards, the instrument number is recorded on the card and when the instrument is returned the card is filed on a pin with all other cards for the same instrument. The number of cards on a pin for a period such as a semester is evidence of the use an instrument receives. The use of individual requisition cards aids in determining the responsibility for damages to instruments. Except for ordinary wear and tear, where responsibility is evident the individuals are charged for any damage to instruments.

A record also is kept of all repairs made on each instrument in a file containing a card for each instrument. All except major repairs are made in the department calibration laboratory by students trained to do the work, some of whom become quite expert. Instruments requiring extensive repairs are sent to the factory or an authorized service representative. An examination of the repair record, when it has been in use for a longer time, will show what repairs and adjustments are most often required for any type of instrument and comparison with the service record will show how repairs are related to the use an instrument receives.

The service record also will show which instruments are not being used. The rebuilding of idle instruments into those having ranges in demand will help to reduce the cost of laboratory instruction, a question which is now receiving considerable attention. As a rule, multirange instruments will provide the same facilities at lower cost than single or double range instruments, but there is more probability that the lower ranges may be overloaded and damaged. The practice of protecting instruments with fuses where it is possible to do so may present a partial solution to this problem.

The instruments in an educational laboratory are used mostly by individuals who are not trained in their use and who are con-

cerned primarily with an experimental problem rather than the proper use of instruments. Only if the instruments are maintained in good condition will the data obtained be dependable and permit correct conclusions to be drawn. If laboratory courses are justifiable at the present high costs per credit hour, a reasonable amount spent to check and maintain the laboratory instruments, thus permitting better results to be obtained, may represent a real as well as theoretical saving.

## NEW MEMBERS

ANDRAE, STEPHAN C., Instructor in Engineering, Los Angeles City College, Los Angeles, Calif. J. W. Hazen, V. C. George.

BALLARD, LYMAN J., Professor of Engineering, Webb Institute of Naval Architecture, New York City. W. D. Bryans, C. E. Gus.

BARLOW, ROLAND W., Director of Public Relations, Industrial Training Institute, 2154 Lawrence Ave., Chicago, Ill. H. E. Keeler, H. H. Higbie.

BARNES, WILSON R., Instructor in Chemical Engineering, University of Louisville, Louisville, Ky. R. C. Ernst, G. H. Harding.

BELYEA, BYARD C., Instructor in Physics, Northeastern University, Boston, Mass. Asa S. Knowles, Wm. C. White.

BIRGE, RAYMOND T., Professor and Chairman, Dept. of Physics, University of California, Berkeley, Calif. L. M. K. Boelter, E. D. Howe.

BOWMER, WILLIAM S., Instructor in English, University of Louisville, Louisville, Ky. R. C. Ernst, G. H. Harding.

BROTHER A. DENIS, Instructor in Engineering Drawing, Manhattan College, New York City. W. J. O'Donnell, R. T. Weil.

COLLINS, GEORGE B., Assistant Professor of Physics, University of Notre Dame, Notre Dame, Ind. F. W. Horan, J. A. McCarthy.

DUSCHAK, LIONEL H., Professor of Metallurgy, University of California, Berkeley, Calif. L. M. K. Boelter, E. D. Howe.

EVANS, SIDLEY O., Assistant Professor of Electrical Engineering, The Ohio State University, Columbus, Ohio. F. C. Caldwell, H. W. Bibber.

GRANGER, ARMOUR T., Associate Professor of Civil Engineering, University of Tennessee, Knoxville, Tenn. N. W. Dougherty, F. L. Bishop.

GRASSO, SALVATORE, Instructor in Civil Engineering, University of New Hampshire, Durham, N. H. E. W. Bowler, Geo. W. Case.

HUTCHINSON, F. W., Instructor in Mechanical Engineering, University of California, Berkeley, Calif. L. M. K. Boelter, B. F. Raber.

JONASSEN, FINN, Instructor in Mechanical Engineering, University of California, Berkeley, Calif. C. F. Garland, F. H. Cherry.

KOOPMAN, RICHARD J. W., Assistant Professor of Electrical Engineering, University of Kansas, Lawrence, Kans. V. P. Hessler, E. D. Hay.

LAKE, WILFRED S., Professor of Economics, Northeastern University, Boston, Mass. (re-admission). Asa S. Knowles, W. C. White.

LINDEMANN, ALBERT J., Instructor in General Engineering, Rutgers University, New Brunswick, N. J. U. C. Holland, P. H. Daggett.

MANIFOLD, GEORGE O., Instructor in Mechanical Engineering, University of Pittsburgh, Pittsburgh, Pa. J. A. Dent, H. C. Pavian.

MARTINELLI, RAYMOND C., Instructor in Mechanical Engineering, University of California, Berkeley, Calif. H. B. Langille, B. F. Raber.

MASK, FRANCIS E., Instructor in Mathematics, North Carolina State College, Raleigh, N. C. J. W. Cell, R. C. Bullock.

MCLEAN, WILLIAM G., Instructor in Mechanical Engineering, Lafayette College, Easton, Pa. E. M. Fernald, Lynn Perry.

MILGRAM, ARTHUR N., Instructor in Mathematics, University of Notre Dame, Notre Dame, Ind. F. W. Horan, J. A. McCarthy.

NELSON, ERIC W., Instructor in Mechanical Engineering, Lafayette College, Easton, Pa. E. M. Fernald, Lynn Perry.

OSTROM, CHARLES D. V., Instructor in Civil Engineering, University of California, Berkeley, Calif. R. E. Davis, H. E. Davis.

PEARSON, DONALD S., Assistant Professor of Electrical Engineering, Ohio Northern University, Ada, Ohio. J. A. Needy, A. R. Webb.

PETERSON, F. G. ERIC, Instructor in Mechanics, University of Minnesota, Minneapolis, Minn. (Re-admission.)

PROBERT, FRANK H., Dean, College of Mining, University of California, Berkeley, Calif. (Re-admission.) B. M. Woods, B. F. Raber.

RAMBERG, EIVIND G. F., Instructor in Civil Engineering, Cooper Union, New York City. Lawrence Perez, P. N. Robbins.

RENNER, WILLIAM E., Assistant Professor of Administrative Engineering, Syracuse University, Syracuse, N. Y. Louis Mitchell, H. W. Blackburn.

STOCKING, ERNEST J., Principal Examiner, Engineering, U. S. Civil Service Commission, Washington, D. C. (Re-admission.)

TOWLE, GEORGE W., Associate Professor of Coördination, Northeastern University, Boston, Mass. (Re-admission.) A. S. Knowles, W. C. White.

WILLIAMS, EVERARD M., Instructor in Electrical Engineering, The Pennsylvania State College, State College, Pa. L. A. Doggett, C. B. Holt.

Associate institutional membership: Mississippi State College.

136 new individual—1 institutional

## COLLEGE NOTES

F. M. Feiker, since 1934 executive secretary of American Engineering Council, has been appointed dean of engineering of the **George Washington University** effective December 15, 1939. He succeeds the late Dean John R. Lapham, whose death occurred in October. Although Dean Feiker's appointment takes effect immediately, arrangements have been made for the continuation of his connection with Council pending the selection of a successor.

**University of Idaho.**—Two new instructors have been added to the engineering staff, Mr. Henry M. Metcalfe to the civil engineering department, and Mr. Carl W. Brown to the electrical engineering department. Mr. Metcalfe was a civil engineering graduate in 1931 from Iowa State College and came to Idaho from the Iowa State Highway Commission. Mr. Carl W. Brown was an electrical engineering graduate in 1932 from Kansas State College, having specialized in communication, and came to Idaho from Iowa State College. Arthur J. Davidson has returned to the civil engineering department after a year's leave of absence. A new graduate assistant has been added to the civil engineering department, Mr. Thomas W. Macartney, a civil engineering graduate from the University of Washington in 1939. Mr. Macartney is specializing in sanitary engineering.

Enrollment in the College of Engineering is 330, compared to 304 a year ago. This represents a record enrollment for this institution.

A number of improvements have been made in the various engineering laboratories. The sanitation laboratory has been enlarged and placed in a room of its own; new high voltage equipment has been put in operation and considerable new equipment has been installed in the chemical engineering laboratory. Equipment has been added to the soils laboratory to test, shear, bearing and swell characteristics of soils. The testing laboratory personnel collaborated with the State Highway Department during the past year and conducted five separate short schools throughout the state, giving a general educational program on soils as they apply to highway engineering.

In November the civil engineering department of the University, the Idaho State Division of Public Health and the Pacific Northwest Section of the American Water Works Association sponsored the Second Annual Short Course for Water Works and Sewage

Treatment Operators. The school lasted for two and a half days and covered not only lectures but laboratory work in chemical and bacterial analyses of water and in microscopy of water. The total enrollment was one hundred twenty-five, sixty-nine of which received certificates of attendance.

The Civilian Pilot Training program of the Civil Aeronautics Authority is in full operation with twenty-seven men and three women enrolled.

**Lehigh University.**—Sophomore civil engineering and N. Y. A. students working in the Structural Models Laboratory, assisted with the construction of a 16-ft. brass wire model of the main spans of the Susquehanna River bridge being built at Havre de Grace, Maryland. Later this model was used by Professor W. J. Eney while working for the fabricator in connection with the stress analysis for the erection program.

Research work in the field of structural engineering is being carried out at the Fritz Engineering Laboratory. The Association of Iron and Steel Engineers is sponsoring a full-time project investigating crane girders. The American Institute of Steel Construction sponsors two half-time research fellowships investigating steel columns and beams in building-frame construction. The American Welding Society is coöperating on an investigation of flexible welded angle connections. Fundamental research on the properties of alloy steels and the fatigue strength of steel wire is also under way.

Robert D. Stout was appointed instructor in Metallurgical Engineering at the beginning of the school year. Mr. Stout graduated at Pennsylvania State College in 1935, tying for first place in a class of over 800 students. Since graduation he has been connected with the Research Department of the Carpenter Steel Company and has also served as an instructor of extension classes in Metallurgy conducted in Reading, Pennsylvania.

**Union College.**—A prominent feature of the Union College program is the Union College Conference on Industry and Government, held under the sponsorship of the Engineering Division of the College, with the coöperation of the Social Studies Division. At the sessions November 1 and 2, 1939 at a panel discussion on Possible Improvements in Unemployment Compensation Laws, the speakers included the heads of the Unemployment Compensation Divisions for the states of New Hampshire, Vermont and New York; Mr. Ewan Clague, the Director of the Bureau of Research and Statistics of the Social Security Board in Washington; and representatives from industry and labor. There are some indications that certain

practicable improvements in methods may be put through on the basis of suggestions developed at the session. Speakers at other sessions of the Conference included W. Gibson Carey, Jr., President of the United States Chamber of Commerce; Hon. Oswald D. Heck, Speaker of the New York State Assembly; Dr. Georges F. Doriot of the Harvard Graduate School of Business Administration; and Comptroller Joseph D. McGoldrick of New York City.

In order to furnish more adequate instruction in Chemistry to students in the Civil and Electrical Engineering courses, the freshman course in Chemistry has been expanded from three to four hours per week and the content modified to include additional demonstration lectures and inspection trips.

These changes in the faculty should be noted:

Joseph E. Paul, B.S. in Electrical Engineering, Union 1938, has been appointed instructor in Electrical Engineering to succeed George Joseph Fiedler, who resigned to accept a position at the University of Montana.

Robert L. Stanley, Bachelor of Mechanical Engineering from Ohio State University in 1936, and then instructor at Rutgers, comes to Union as instructor in engineering in the place of Ernst Winzenburger, who has gone to Germany.

Charles V. Strain, who received his Bachelor of Arts degree from De Pauw University in 1932, and his doctorate from the University of Rochester in 1938, joins the faculty as instructor of Physics in the place of Dr. Overton Luhr who has been granted a leave of absence because of illness.

**Yale University.**—On Saturday, October 21, a tablet honoring John Clayton Tracy, Professor Emeritus and former head of the department of Civil Engineering, was unveiled at the Yale Engineering Camp at East Lyme, Conn.

The tablet, a gift of the class of 1890 of the Sheffield Scientific School, of which Professor Tracy is a member, was placed on the wall of the main instruction and assembly hall, officially naming this building Tracy Hall.

Another tablet was unveiled at the same time to commemorate the acquisition of the property by the Trustees of the Sheffield Scientific School. It was through the untiring efforts of Professor Tracy, starting in 1913, that this property was purchased as a camp-site.

The buildings were erected in 1926 through the generosity of the members of the Yale Engineering Association and others at a cost of about $100,000.

The tract comprises about two thousand acres. On it is a lake about a mile long and a half mile wide. Besides the main building,

now known as Tracy Hall, there are the kitchen and dining hall, instrument house, and wash house, all of which are of field stone, as well as seven wooden barracks accommodating 105 students. The barracks are situated along the west edge of the lake.

New appointees in the School of Engineering are Francis M. Baron, Assistant Professor in Civil Engineering; T. D. Graybeal, C. M. Milner, and C. F. White, Assistants in Instruction in Electrical Engineering; R. H. Bliss, Assistant Professor, and D. S. Brinsmade, Assistant in Instruction in Chemical Engineering; and A. J. Warren, Instructor in Engineering Mechanics.

Mr. Baron is a graduate of the University of Illinois, B.S. '35, M.S. '36, and D.S. '39 Harvard; formerly Superintendent of Construction for L. R. Solomon and Co., architects and engineers of Chicago; Assistant Research Engineer for the Chicago Bridge and Iron Co.; Assistant in Civil Engineering at Illinois; Instructor in Civil Engineering at Harvard.

Troy D. Graybeal is a graduate of the University of Colorado, B.S. '37, and M.S. '39 Massachusetts Institute of Technology; formerly Research Assistant at M. I. T.

Carl M. Milner, B.S. '37, M.S. '39 University of Illinois; formerly Research Assistant in Electrical Engineering in the Engineering Experiment Station of the University of Illinois.

Charles F. White is a graduate of the University of California, B.S. '35, M.S. '38; formerly with the United States Bureau of Reclamation by serving as Instructor in Electrical Engineering at the University of California. He is now taking graduate work at Yale.

A. J. Warren was graduated from Connecticut State College (University) M.S. '33; M.E. '39, Yale University. He has had previous teaching experience in Mathematics and Applied Mechanics.

Harding Bliss, B.S. '32, University of Illinois, Ph.D. '35. He was in charge of Semi-Works, Rohm and Haas Co., Philadelphia 1935–37; Assistant Professor of Chemical Engineering at the University of Pennsylvania 1937–39.

D. S. Brinsmade, B.E., Yale University 1937. He was a chemical engineer at the Naugatuck Chemical Co. (Division of U. S. Rubber Co.) 1937–39.

Professor Charles J. Tilden, who has been Strathcona Professor of Engineering Mechanics since the organization of the department in 1919, is on leave of absence for the academic year. He is devoting his time to the work of the Eno Foundation for Traffic Control, of which he is president. He continues as Chairman of the Transportation Committee of Yale University. His residence is in Westport, Connecticut.

Professor Philip G. Laurson, Associate Professor of Engineering Mechanics, is acting Chairman of the Department of Engineering Mechanics for the current year.

Professors Benjamin R. Teare and Russell G. Warner have resigned. Professor Teare is now Professor in Electrical Engineering at Carnegie Institute of Technology. Professor Warner has accepted a position as engineer for the United Illuminating Company of New Haven, Conn.

Professor Melvin C. Molstad formerly of the Department of Chemical Engineering has resigned to accept a position as Associate Professor of Chemical Engineering at the University of Pennsylvania.

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## NECROLOGY

### LESTER L. SCHULDT

Lester L. Schuldt, Professor of English at the University of Idaho, died Sunday, December 10, 1939, in Moscow, Idaho, after a three weeks' illness. Professor Schuldt was a member of the English Department and taught the advanced work in English to the engineers. He joined the S. P. E. E. in 1936 and took an active interest in all of its activities in the Pacific Northwest.

Professor Schuldt was born in Illinois in 1899, lived in Iowa, Wisconsin and Minnesota, received his bachelor's degree from the University of Minnesota and his master's degree from the University of Idaho. His going is a great loss to the College of Engineering because he had the rare ability of inspiring students to real effort. He required hard work, and gave high grades only when they were deserved. All the engineering students looked to him as a friend and advisor and consulted him on their English problems long after they ceased to be members of his class. Professor Schuldt was an exceptional teacher and an inspiration to all.

## SECTIONS AND BRANCHES

The first meeting of the **Northeastern University Branch** was held on Tuesday, November 28, at 6:00 P.M. A constitution was adopted and President Chester P. Baker outlined the program of activities for the current year. Dean Knowles summarized the activities of the membership committee of the National Society. Following the business meeting, Dean White presented a paper on the status of the professional licensure movement in engineering.

Licensing of engineers dates from 1907 when the first licensure law was adopted by the State of Wyoming. Since that date, registration laws have steadily increased until, at present, only five states have neither voluntary nor compulsory registration. Registration laws are also in force in Hawaii, Puerto Rico, the Philippines, and in eight Canadian Provinces. Although there is yet a wide variation in the statutes, a trend toward uniformity has been fostered by the American Engineering Council, American Society of Civil Engineers, National Council of State Boards of Engineering Examiners, and other professional societies. The most widely discussed model laws are those of the A. S. C. E. and A. I. E. E. At present, twelve states follow the A. S. C. E. model law and although that of the A. I. E. E. is widely approved it is too new to have received legislative consideration. The following conclusions were drawn from the available data:

(*a*) There has been an unbroken trend toward registration since 1907. No state has repealed its licensing laws except to make them more satisfactory.

(*b*) There is a tendency toward uniformity in state registration laws. This is retarded by variations in state constitutions.

(*c*) Substantial numbers of engineering societies favor the licensure of engineers. There is general sentiment that engineers should be licensed as professional engineers and not as practitioners of some specific branch of engineering.

(*d*) In Massachusetts there is still widespread lack of information on and apathy toward the subject of registration among the engineering fraternity.

(*e*) In view of its importance to all engineers, it is highly desirable that the problem be widely studied and discussed before a licensure bill is next presented to the legislature so that our engineering constituencies may deal intelligently with whatever bill is introduced.

The paper was actively discussed by the Branch membership.

WILLIAM T. ALEXANDER,
*Secretary*

# CIVIL ENGINEERING PAGE

*Notes of interest for members of the Civil Engineering Division.*
*—Editor,* EDWARD E. BAUER, *University of Illinois, Urbana*

M. W. FURR, *Chairman*
F. T. MAVIS, *Past Chairman*
PAUL P. RICE, *Secretary*
EDWARD E. BAUER, *Editor*
L. G. STRAUB
F. W. STUBBS, JR.
H. T. HEALD

## SUMMARY OF REPORT OF THE COMMITTEE ON TEACHING HIGHWAY ENGINEERING AND HIGHWAY TRANSPORTATION *

BY M. W. FURR

Professor of Civil Engineering, Kansas State College, Manhattan, Kansas

In January, 1936, the Educational Division of the American Road Builders' Association was organized. One of the standing committees of that Division is the Committee on Teaching Highway Engineering and Highway Transportation Courses to Undergraduate Students. This Committee has been active for the past three years, and its fourth report is in the hands of the Executive Committee pending publication in the 1939 Convention Proceedings. The personnel of the Committee has been the same since its beginning. The members are: Professors S. L. Conner, Tufts College; R. L. Sumwalt, University of South Carolina; J. C. Park, University of Arizona; D. V. Terrell, University of Kentucky; and M. W. Furr, Chairman, Kansas State College. This Committee stands ready to coöperate with other Committees on transportation, and I am pleased to give a brief resumé of its activities on this occasion.

The Committee has made several contacts, and in two instances which I recall, communications were with Professor R. L. Morrison, Chairman of the Committee on Teaching Highway Engineering and Transportation of the American Society of Civil Engineers, and Professor Harold C. Bird, Chairman of Committee IV, Transportation, 1936, of the S. P. E. E. There is some overlapping of effort and accomplishments, perhaps, but this will be of mutual advantage and benefit. It will be possible to review in the allotted time each of the annual reports.

In the first year the organization of the Division was consummated. Some of the general aspects of teaching highway engineerng and the problems encountered by the teacher in doing his work from day-to-day were presented. It seems to me that one of the most important points brought out at the first conference of highway engineering teachers of the Association was the emphasis placed upon the fact that to teach Highway Engineering properly is to teach the subject partly and rather fully as Transportation Engineering, Economics and Highway Planning. The consensus seemed to be for a new approach; suggestions were that certain courses of long standing be combined or revised—dropping some material of precedented sequence for a richer, broader, apprehensible, course.

* Presentel at S. P. E. E. Civil Engineering Division Conference on Committee IV, Transportation, at State College, Pennsylvania, June, 1939.

With the exception of the first year the various phases of engineering education in road building have been studied and disposed of by committees. The principal point of interest the second year was the question of the organization of a course or courses to be taught by the Civil Engineering faculty to cover the theme of transportation. There was first the question of sequence, and the plan conceived was that the first step in the proposal would be to present the rudimentary principles of transportation, along with a course which is familiar to all of you, having been called for many years by some institutions Railroad Curves and Earthwork. I think that it was discovered by the Committee that there has been a slow but gradual change from the use of the name stated above to Route Surveying. For a number of years this beginning course in the transportation sequence has been called Surveying IV, or Civil Engineering 162, or the like by some schools. At the same time there has been the tendency to change the nature of the work to include highway curves and earthwork in the course just mentioned and in more recent years to include certain phases of transportation and communication facilities. The Committee endeavoured to deal with the questions of what, with what, when, and how to teach the subject matter deemed to be of most value in building up a background for the engineering student in the field of transportation generally. It was also agreed by the Committee that certain fundamentals, both technical and economic should be stressed. About this time in most sections of the country undergraduate engineering students lost interest in highway engineering training.

The A. R. B. A. Committee proceeded into the work of the third year. A conclusion was reached that the highway engineering courses, and for that matter any course in transportation, should include theoretical material relating to the design, construction, administration, operation, and maintenance of the principal practices in the separate transportation fields.

It was understood that at some of the institutions, combined courses in railway and highway transportation were being attempted. The Committee was unable to obtain any outlines for exhibition. Also, it was pointed out that the highway engineering teacher was obliged to explain a multiplicity of rather complicated principles in teaching the beginning transportation courses and that because of so many intricate examples and aspects of the subject, coupled with the short time allotted to the course that it was rather difficult to do the job as well as one would like.

Professor Earl C. Thomas of Stanford University, a guest speaker for our Committee at the San Francisco meeting, points out in our fourth annual report that, no longer does the civil engineer's college course consist largely of elementary mathematics, surveying, map-drafting, and the economic theory of railroad location. Thorough grounding in the physical sciences, including higher mathematics, physics, and chemistry have now become an essential requirement in all branches of engineering. Moreover, it has become necessary to devote ever increasing amounts of time to theoretical mechanics, the study of the engineering properties of materials, hydraulics, stress analysis, and structural design. The broadening sphere of engineering activities has brought realization of the importance of training in engineering economy. The extensive invasion by engineers of the administrative fields has led to the rather general recognition of the necessity for inclusion of English, social science, statistical analysis, business law, and a general broad training in the purely academic subjects.

Gradually these additional basic requirements for engineering training have crowded out of the undergraduate curricula much of the specialized training which was possible under former conditions. The objectives of undergraduate engineering education have also necessarily undergone considerable change. The charge that we are turning out incompetent technicians is untrue, except

perhaps in the case of a very few institutions where they cling tenaciously to the old standards and do not recognize the changing requirements. Our graduates are now receiving training designed to qualify them for development not only along purely technical lines, but also in administrative work.

If we are to prepare our students properly, we must give them thorough training in the fundamentals; obviously, there is little time in the four-year undergraduate course for specialization. The fundamental sciences can be acquired much more easily and thoroughly in school than in the field of experience. On the contrary, skill, specialized applications, and sound judgment can be more easily acquired in the field of experience. Study in the fields of letters, law, and social science will probably never be undertaken by prospective engineers unless such subjects are included in school work. I believe that it is more important for the school work to be a factor to stimulate intellectual curiosity than it is to introduce the intricacies of asphaltic pavement construction; that mental discipline and orderly habits of work are more essential to early training than skill in any particular specialty; that the ability to evaluate facts and to deal with them impartially and logically is of paramount importance; that development of a sense of values and of their significance should be a major consideration in the design of engineering school courses.

Professor Thomas continues, despite the huge proportions of the highway program and despite the many highly interesting and unsolved problems with which the highway engineer has to deal, very few of our better class civil engineering graduates are being attracted to this branch of the profession. If there is any field in which high calibre men are needed, it is in highway engineering. *What is the reason for this?* One prominent educator recently suggested that there is "too much politics." Professor Thomas claims no intimate knowledge of conditions affecting states other than California, but he finds no evidence that politics appreciably affect job security or opportunity for advancement in the State of California. *Is the remuneration too low?* The facts do not support this supposition. Particularly in the lower brackets where university graduates normally start, highway engineering offers salaries quite as attractive as those paid in other branches of the profession. *How about opportunities for advancement?* In the lower brackets they are quite as good as in other lines. However, as we approach the executive positions the promise is not quite as good as in certain other types of organization. This probably accounts for some of the desertions from highway work to other fields; but it does not explain the general unpopularity of highway engineering work among recent graduates. It must be remembered that highway engineering employment has the very definite attraction of security under civil service regulations. Despite this advantage, highway engineering employment is not being sought with any great eagerness.

Finally, Professor Thomas stated that it was his opinion that the real reason can be summed up in one word—"over-standardization"—the same thing which caused similar avoidance of railroad employment. He does not condemn standardization; it is necessary in some degree in large organizations and extensive operations. But, the fact remains that the alert and intelligent mind resents the throttling down of initiative and the routine drudgery of standardized work. If the men who are to fill the executive positions in the future are to be brought up through the ranks, some effective steps must be taken to obviate this difficulty. He has no remedy to suggest, but it seems reasonable to conclude that the first step toward a solution might well be the establishing of closer coöperation between highway officials and engineering educators. Through mutual understanding and discussion of each other's problems it is possible that some measure of improvement might be accomplished.

# ENGINEERING ECONOMY PAGE

*Engineering economy is that phase of engineering which pertains to the specifically advantageous use of dollars and cents in engineering works.*

EDMUND D. AYRES, University of Wisconsin, *Editor*

As the beginning of the New Year is devoted traditionally to "taking stock" of our past performances and to carrying out new resolutions and policies, your editor would like to raise the question whether or not the month after month treatment of a single special subject such as replacement economy tends to dissipate reader interest. Then for a "brand new" policy he suggests the trial of a Question Box style.

It is thought that the question and answer style of treatment can be made to accommodate itself more advantageously to the limited space available and to carry reader interest over from one month to the next by announcing the question one month and printing the answer the next. It is believed that a wider reader response can be hoped for if the range of subject matter can be broadened in this way. Perhaps it will be possible to induce the contributors of answers to questions to condense the answer to be published to a statement of the gist of the matter and to accompany this with or hold ready for more complete discussion a prepared statement to be sent to those who might be inclined to discuss the subject further.

To start off this suggestion the following questions are presented for reader consideration:

1. In the solution of engineering economy problems in practice what criterion should determine when compound interest should be used?
2. What rules should be set up for handling depreciation in engineering economy studies when amortization of a borrowed equity is involved?
3. Is it possible to determine a valid economic death point for equipment without resorting to a comparison of the old equipment with new?
4. Is it ever correct to consider an equipment as having a negative value for comparison purposes in a replacement economy problem.

Answers, criticisms, and refinements are earnestly solicited. Now is your chance to throw in to the ring those controversial queries to which you are seeking an answer or some gauge of opinion. Help give the new idea a real trial.

Short papers of 500 words or less treating some aspect of engineering economy will continue to be interspersed between question-answer months if our contributors will continue to express themselves upon vital matters as they have in the past.

# ENGLISH NOTES

DEVOTED TO THE INTERESTS OF TEACHERS
OF ENGLISH IN ENGINEERING SCHOOLS

J. L. VAUGHAN, *Editor*, University of Virginia

## THE ENGINEERING-ENGLISH TEACHER'S TRAINING, AND HIS PROPER TEACHING LOAD

By L. A. ROSE

Professor of English and Foreign Languages, Michigan College of Mining and Technology

Captious as it may seem for English instructors to take exception to the findings reported in Knowles and White's "Evaluation of Faculty Loads in Institutions of Higher Learning," in the June JOURNAL OF ENGINEERING EDUCATION, nevertheless upon three matters pertaining to English instruction the Michigan College of Mining and Technology English Department wishes to register its dissent.

Our objection is neither to Knowles and White's procedure nor to their insistence that "higher education is a business . . . in which the administrator is charged with the intelligent direction and use of the nation's most valuable resource—its learned men." Both their investigative technique and their thesis appear to us entirely sound. Our objection is to the opinions and data furnished by twenty-five teachers of English. Most of these contributors have not, it would seem, grasped the implications of the statement which I quoted above. They have not applied to their own jobs the principles of scientific management. Instead, they exaggerate the time which needs to be spent on their activities. And they do so, we believe, not only because they have failed to analyze their tasks into sufficiently fine components but also because in selecting colleagues and subordinates they are willing to accept persons who are not well enough trained academically or practically.

The preceding paragraph indicates the three matters on which we dissent from the findings presented by Knowles and White. Since it is upon the two issues last named—matters of teacher-train-

ing—that our dissent is without qualification, I treat them first, and leave till the end of this article our data regarding a time budget for freshman English.

1. Of the twenty-five men who answered the Knowles-White questionnaire concerning freshman English, ten consider a bachelor's degree sufficient for the instructor, fifteen a master's—presumably a "bare" master's.

The view expressed by the ten, we hold to be unsound, certainly for colleges which endeavor to teach true Engineering English, and indeed for colleges where engineers are subjected to liberal-arts English. For even if, in their content, our courses disregard engineers' needs, it is still true that our teaching methods must conform to engineers' interests. This means that we instructors cannot give explanations which are superficial or which strike the engineer as superficial. He will not stand for a mere *ipsi diximus*. We must, then, have sufficient knowledge to be able to blend judiciously these four techniques: a convincing exposition of prescriptive orthography, grammar, and rhetoric; the application of mnemonic devices; historical and genetic explanations; and such methods as exist for inculcating those virtues of style which defy reduction to rule and principle. Let us grant at once that a teacher can use the first two of these techniques without having more than a B.A. degree—in fact, without having any college degree at all. But the application of the other two, and the effective combination of all four in the classroom, is greatly aided by graduate study; moreover, it is hardly possible without graduate study. It has been not only our experience but our observation that the average college English instructor who has only a B.A. is one-sided. He is, without knowing that he is, a tenth transmitter of the errors (seldom, however, of the virtues) exemplified by the eighteenth-century "rationalistic" grammarians and rhetoricians. Or else he is a mere drillmaster. Or else he is an inept expositor of the *je ne sais quoi* school of esthetics.

Even when he avoids these dangers, he ordinarily remains nothing more than an acceptable teacher of non-engineering English —that is, of a course either wholly unadapted to engineers, or adapted only to their easier and most immediate demands, to their business-college and trade-school proclivities. Such an instructor does not possess enough knowledge to see Engineering English in its present relation (let alone its past and its probable future relation) to other forms of writing.

Indeed it is questionable whether the man with a bare M.A. is in much better case. We at Michigan Tech have found, and from many conversations we are sure other colleges have found, that

one year of training past the M.A. is a necessary corrective for the acknowledged faults of graduate study.

2. Certainly, if a man with only one year of graduate work is to be a good teacher of freshman English to engineers, he must have supplemented his academic training by means of both teaching and practical writing. We take our stand with the thirty-six per cent of Knowles and White's contributors who ask for some

ANALYSIS OF TEACHING LOAD IMPOSED ON EXPERIENCED TEACHERS BY THE MICHIGAN TECH FRESHMAN ENGLISH COURSE
(Adjusted to 30 students per section)

| Nature of Section | Class Hours | Preparation* | Correction | Student Confs. | Staff Confs. | Bookkeeping† | Total | Ratio |
|---|---|---|---|---|---|---|---|---|
| Fast | 3 | 1.5 | 2 | .2 | .3 | .4 | 7.4 | 2.47 |
| Fast and medium | 3 | 2 | 2.6 | 1 | .3 | .8 | 9.7 | 3.23 |
| Medium | 3 | 2 | 3 | 1 | .3 | 1 | 10.3 | 3.43 |
| Mixed | 3 | 3 | 3 | 1.5 | .6 | 1.5 | 12.6 | 4.2 |
| Slow | 3 | 3.5 | 3.6 | 2 | 1 | 2 | 15.1 | 5.03 |
| Spelling | 1 | 1.5 | .3 | 1 | .2 | .2 | 4.2 | 4.2 |

FIG. 1

* As Knowles and White state on page 809, average preparation hours per section can of course be reduced as the number of comparable sections per instructor increases. Since, however, their Fig. III takes no account of such reduction, our figure disregards it likewise.

† We have clerical aid to the extent of about 7 hours more a week than does the average department of our size. On the other hand, we record individual errors in much more detail than do most English departments, and summarize them pretty thoroughly; the time spent in planning lessons by the aid of such summaries is, naturally, allocated to preparation.

Figure 1 takes no account of our practice, shared by many other English departments, of using some proctoring hours for the correction of simple types of themes and for the recording of grades.

teaching experience. Only, few of the contributors go far enough. We believe that a man needs to have taught for at least three years before he can give a good course in freshman English in an engineering college; and that, ideally, he should also have done practical writing for an equally long period.*

3. The foregoing assertions ally themselves, of course, with our dissent from the summarized opinion concerning the minimum time

* Possibly this last contention of ours merely restates what several colleagues have in mind when (Fig. I) they list ability in creative writing, criticism, and editorial work as "special necessary training." But where (so we judge) they merely favor, we would insist; and where (so we judge) they might accept amateur writing ability, we want proved, commercial writing ability.

required for the teaching of English. Obviously, the type of Engineering English instructor whom we favor cannot usually be secured—or, in any event, held—if his teaching load is to be as heavy as Fig. III of the Knowles-White study shows.

But it need not be so heavy. The time spent on English should average, not 5.5 times the class hours, but about 4.3 times; should split the difference between the rule-of-thumb 3–1 ratio and the excessive figure arrived at from the opinions of the twenty-five contributors to Knowles and White's investigation.

Consequently English departments can do what seems impracticable if the Knowles-White findings are correct: they *can* hire well-trained men, *can* pay them enough to recompense them for their graduate training, and *can* work them at a fast pace but not work them to death.

Since our own investigations of the time problem cover only the last four terms, we do not wish to be dogmatic about the generalizations given above. But we do consider the Knowles-White budget too charitable. Hence we now offer, as a basis for discussion and controversy, an account of our own practice.

Figure 1 gives the essentials of our teaching-time budget during the past academic year.

Our setup as regards class hours and total student load is about the same as was assumed in the Knowles-White questionnaire.*

Under our actual allocation of our 210 freshmen in each of the past three terms (an average of 26.25 instead of 30 students per section), the average total teaching load was 90.3 hours a week, whereas the Knowles-White chart would yield between 118 and 120 hours a week; and even if, to our figures, six or seven hours a week were to be added for teachers' bookkeeping, the total would be about 97 as against virtually 120.

A college with twice our enrollment could, then, easily save one instructor; and a college with approximately our enrollment could

* Experienced teachers, three class hours a week, and the assignment of at least one theme and one written quiz per week. However, we find it neither possible nor desirable to have 30 students per section. Our one or two fast sections per term usually run to about 25 men. Our slow sections we try to keep below 22; they have averaged 22.8. Mixed sections of from 25 to 33 students have sometimes resulted from local scheduling problems. For forty per cent of the year—the first third, roughly, of the first term and all of the third term—every section is a mixed one: We segregate on the basis of the first eleven meetings; we break up the segregation after the second term to prevent weak students from thinking too highly of their abilities. Our remedial spelling section of 20 students has required 3.1 hours weekly from the instructor. Next year, when it will contain 30 men, it will take about four and a quarter hours.

let one instructor of freshman sections devote nearly half his 45 hours a week to other teaching, to editorial work, or to publicity.*

Let me emphasize three things concerning the statistics we have given. They are based on a curriculum which, we believe, is at least as difficult as the average freshman English curriculum, and as fruitful for the student. They make—but they should make—no allowance for instructorial laziness masquerading as helpfulness to students or under any other guise. Thirdly, two if not three more years of continued computation and analysis, based on two or three more crops of freshmen, will of course be necessary before we can support our generalizations completely.

But we doubt that our time budget will ever be found badly out of line. We see no reason, for instance, why instructors should not always be able to check an average of 75 spelling words per minute. We see no reason why papers should not continue to be alphabetized and recorded at the rate of 12 a minute. We see no reason why true-false tests cannot be marked at the rate of 50 items a minute. And so on. Only the matriculation of a class most of whose members are very weak in English could, it seems to us, force us to raise our time estimates greatly. Even should we have to increase the hours devoted to preparation, correction, and bookkeeping we could—as is obvious to all English instructors—regain some of the lost time. For instance, we could occasionally combine sections for lectures and for certain types of quizzes. And we could be more careful in utilizing conference periods. We are inclined to think that English teachers waste much time in conference; that a short consultation can do little to help a student, and that a long one, on the other hand, often becomes a spoon-feeding session.†

In offering our dissent from some of the Knowles-White summaries of opinion, what we have in substance been asserting is that most of the twenty-five English contributors are not as wise as Knowles and White; are too far off the trail blazed by Taylor and Halsey; do not analyze the English-teaching job in sufficient detail; and hence fail to see wherein time is wasted, whether by inadequately trained instructors or by the self-indulgence to which all of us are liable.

* Administrators would, naturally, be interested in the comparative costs under our system and under that implied by the answers given to Knowles and White. Under our system, a college with about 500 freshmen could recompense its instructors adequately for their graduate training and for their practical and their teaching experience; could pay the department head $400 a year more than otherwise; and could still keep slightly under the budget presumably necessitated by the Knowles-White statistics. At the same time, the teaching efficiency would be higher and the labor turnover should be less.

† It would be desirable to replace by quantitative data our emotionally phrased opinion of conferences, but this is precluded by the virtual impossibility of setting up comparable control and experimental sections.

And, we submit, such weaknesses can do no real service to English teaching or to English teachers. Deans and presidents will listen to our pleas more readily if we do not exaggerate our burden. English does indeed require more time than the traditional 3–1 ratio allows. For showing the inadequacy of that ratio the Knowles-White contributors are to be commended. But English teaching should not, if we are alert to cut out waste, require any 5.5–1 ratio; and to say that it does, is to harm rather than help our profession.

# MECHANICAL ENGINEERING PAGE

*Those who personally dominate are heroes for the hour; those who build men are immortals.*

R. L. SWEIGERT, Georgia School of Technology, *Editor*

This issue of the page concludes the remarks on "Manufacturing Processes Laboratory Methods." The contributors have shown a remarkable agreement as to both the objective and the methods to be used in these laboratories. It is believed that the way has been indicated to make these laboratories the most effective for engineering education.

## COMMENTS BY PROFESSOR M. P. CLEGHORN OF IOWA STATE COLLEGE

There are two views which might be taken with reference to shop training. One view sees only the fact that a knowledge of shop work is necessary for the young man in industry, and therefore, the shop is operated for this one reason alone. Some feel that the training, if needed, can be obtained after graduation and that a college shop is unnecessary. The other view is that the shop training should develop a knowledge of metals and their processing and have some definite relation to the other courses taught in the Mechanical Engineering Department, or other departments having courses similar to mechanical engineering, and train the young engineer for future industrial occupation.

It seems to me that the shops and the so-called manufacturing Processes Laboratories cannot be separated to the extent that some would like to have them separated. Any metal processing laboratory work requires machines (shop machines), and these should be operated by the students and, as I see it, not by the instructors as demonstration projects.

We no longer teach pattern making. In the course in Metal Casting the student is brought face to face with a very carefully chosen group of patterns, the use of which will bring to his attention the required shape and construction of patterns and core boxes, as well as difficulties encountered with an improperly constructed pattern. In order to show the student that differences do exist between various foundry sands, he is taken to the foundry sand testing laboratory where he conducts some of the more important physical tests upon the sands and compares their properties. Metals of different composition are made up, melted in the electric furnace, cast and tested, thus bringing out the effect of different constituents in the metals. For some of the alloys the temperature at which the metal is poured is noted and results compared. Various chilling methods for iron are also compared. In this metal casting course we use a textbook on Foundry Practice as a basis for class discussion.

A course, "Heat Treating of Metals," is offered by the Mechanical Engineering Department in the spring quarter, sophomore year, and is required for all mechanical engineering students. This course consists of two one-hour recitations per week and two three hour laboratories per week. It covers the usual work on the effect of heat treatment not only on steel, but also on some of the other metals. We consider this work a part of our shop training, and it is tied in closely with the other shops. This work demonstrates the relationship of various heat treatments to the material properties.

In the junior year we offer a shop course which we call "Advanced Metal Shop." This laboratory is for the purpose of studying tool materials and shapes, cutting speeds, power requirements, etc. This course is dependent to the considerable extent upon the heat treating course just mentioned. The course is made up on one 1-hour recitation and one 3-hour laboratory per week. No blacksmith or forge shop work is taught. Some information on the effect of hot and cold working of metals, however, is gained in the heat treating laboratory by tests after such working.

## COMMENTS BY PROFESSOR L. G. MILLER OF MICHIGAN STATE COLLEGE

I have spent considerable time thinking just what is the difference between trade training and engineering education anyway, and I came to the conclusion that trade training is teaching the student or the person to do the thing, while engineering education is teaching them how it is done. . . . I think that processing laboratories should be retained. . . . Our teachers teach metal processing. . . . We have a form of pattern shop in which they do experiments. . . .

## COMMENTS BY PROFESSOR EDGAR MACNAUGHTON OF TUFTS COLLEGE

I do have a few points of view on this subject. My field is machine design and industrial management. I feel that shop laboratory courses are necessary. . . . Whatever occurs I believe it will be a great loss in the education of a Mechanical Engineer if the shop courses disappear because I believe they have values which cannot be obtained elsewhere.

## COMMENTS BY PROFESSOR HAM, UNIVERSITY OF ILLINOIS

Time in the shop has given way to theory work in the classroom. The shop has ceased to be just a shop and has taken on the aspects of an educational laboratory. I speak from the viewpoint of the machine design instructor. I have had the opportunity to observe students coming to us in machine design from the old-time shop course of the manual training type such as I conducted in the earlier period, and from the new "manufacturing processes laboratory," such as we now have, and I believe that I can sense the fact that in the latter case these students have shown a broader knowledge of materials, design, the fundamental principles of engineering, and the economic phases of production and manufacturing.

It is true that under the same conditions the alert instructor today, with the proper objectives before him, can accomplish much as compared with what was accomplished in the old shop course where the manual training idea predominated, but it seems to me we can have a shop laboratory just as we have a power laboratory or any other laboratory. In doing so it is possible that the student can spend less time operating a machine, better use can be made of the equipment, more students can be accommodated in a given laboratory, and the student may profit to a far greater extent. The manner in which this can be and is being accomplished in a machine tool laboratory has been set forth in detail by Professor F. H. Thomas in the June issue of the JOURNAL.

One of the greatest difficulties the machine design instructor must contend with is the average student's lack of technical knowledge of materials, tools, machines, and processes. To have a student coming to him without any shop course, or its equivalent, would be unthinkable. The student coming to him from the old-time shop course is handicapped. I am convinced that the student

comes to us best equipped who has been trained in courses having the objectives and instructional methods set forth in Dr. Sweigert's paper.

## COMMENTS BY PROFESSOR F. L. EIDMANN OF COLUMBIA UNIVERSITY

In talking with manufacturers asking them their opinions as to what should be done or how a shop course should be handled, they feel that the student should get the feel of the machine. That is where the laboratory work comes in. Why not give a series of experiments of an engineering nature during which a student has to use a machine to determine certain data. Just a few experiments might be as follows: we might give three or four students a half dozen pieces of tool steel, the pieces having been annealled, then specify six different heat treatments to be given. Or we might take the same six pieces of steel, sharpen them all exactly alike, and let the student give them a life test. In doing this the student is less likely to forget the importance of a heat treatment. We might try an experiment on the drill press to determine the relationship of tool pressure and drill speed.

These are only some suggestions. In the plan I have just mentioned the investment of equipment is much lower than where you have manual training. . . .

## COMMENTS BY A. L. TOWNSEND OF MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Professor R. L. Smith decided that the way to teach the things which should be taught was to emphasize processes and materials to the almost complete elimination of the "project" idea, that is to say not to build something for the sake of building it and letting the methods and processes be secondary, but to reverse the idea.

Professor Smith emphasized the limitations of the various machines which he had at his disposal, and impressed upon the students the relation of the tool end material to effective machineability. Upon these principles, written down by Professor Smith some forty years ago, our Machine Tool Laboratory has operated ever since. . . .

The foundry in its transformation has, in a very real sense, become a laboratory of cast metals in which metallurgy and processing have important places. Sand control and sand testing are equally emphasized, and the foundry technique as far as the individual operator is concerned is very much in the minimum. The work is quite popular with the students; the only disturbing element being the usual bane of student life—reports. Welding Laboratory has also changed.

The old blacksmith shop or forging laboratory also undergone a complete change. It is now, in fact, a laboratory for the study of the plastic behavior of metals. The work is conducted in very much the same way as in the cast metal laboratory, in which processes and methods are emphasized. No attempt is made to encourage the skill of the student. . . .

If we are still to have laboratories of Physics and Chemistry in connection with lectures and recitation sections, I believe we are fully justified in having mechanical processes laboratories on the same level and conducted with the same amount of dignity and operated under the same philosophies. . . . Unless these so-called shop courses are conducted in the most efficient manner possible, we may find that the time allotted to these subjects will be slowly but surely compressed to extinction. I think it is necessary for all of us to give the utmost attention to the course handling of the subject matter under discussion, and thus fortify ourselves, in the field of the mechanical engineer, against the attacks of the mechanical scientist.

# THE T-SQUARE PAGE

DEVOTED TO THE INTERESTS OF THE
DIVISION OF ENGINEERING DRAWING

A. W. LEIGHTON, *Editor*, Tufts College

## NATIONAL DRAWING COMPETITION

GENERAL REGULATIONS FOR SCHOOL YEAR, 1939–1940

Auspices of the Division of Drawing and Descriptive Geometry,
Society for the Promotion of Engineering Education

*Chairman*, STANLEY G. HALL, 314 Transportation Building, University of Illinois, Urbana, Illinois

1. Work is limited to first year (or equivalent) drawing courses. Students in advanced courses or who have been professionally employed as draftsmen should not be entered.

2. An engineering drawing department may submit one drawing only in each of the following competition classes: AP, AI, BP, BI, CI, CS, D, E, and F. No student shall enter drawings in more than one class.

3. Each submitted drawing must be accompanied by a statement concerning the following information:

*a.* The competition class in which the drawing is to be entered.
*b.* The name and address of institution and name of instructor.
*c.* The number and length of lecture or class periods, the number and length of drawing room periods, and the number of "home work" periods which were available to the student prior to and including the time spent on the submitted drawing.
*d.* The number of units, semester hours credit, or yearly credit of mechanical drawing earned by the student competitor before entering college.
*e.* The name and address of the student whose drawing is submitted.

4. The problems and specifications supplementing these general rules will be furnished schools desiring to enter contestants. Application, accompanied by an entry fee of one dollar, should be made to the Chairman of the Competition Committee, who will supply the necessary problem specifications, identification numbers, and cards for listing the information referred to in paragraph three. Specifications will be furnished to contesting students through their instructors. The school's best drawing in each competition class will be entered in the National Competition. An elimination contest in each school is suggested as one means of selecting the best drawing.

### THE CLASSES IN GENERAL

In all cases the drawing is to be made from the problem project supplied by the Drawing Competition Committee and in accord with the specifications and regulations which apply to the particular classification.

*Class AP.*—Required: A pencil drawing on tracing paper or cloth, made with instruments and embodying orthographic shape description. Choice and treatment of views, as well as execution, are a part of the problem.

*Class AI.*—Same as Class AP except that an inked tracing on cloth (accompanied by the pencil drawing on heavy drawing paper) is required.

*Class BP.*—Required: A pencil drawing on tracing paper or cloth, made with instruments, including both orthographic shape description and size specification. Choice and treatment of views, execution, dimensions, etc., are part of the problem.

*Class BI.*—Same as Class BP except that an inked tracing on cloth (accompanied by the pencil drawing on heavy drawing paper) is required.

*Class CI.*—Required: A complete working (shop) drawing in the form of an inked tracing on cloth, accompanied by the pencil drawing on heavy drawing paper. Choice and treatment of views, dimensioning, etc., are a part of the problem.

*Class CS.*—Same as Class CI except that the drawing is to be a freehand orthographic sketch on plain heavy drawing paper.

*Class D.*—Required: A freehand pictorial sketch without mechanical aids of any kind. Choice of position, method of representation, execution, etc., are a part of the problem. Line drawings are desired rather than photographic effects produced by shading.

*Class E.*—Required: Lettering in pencil and lettering in ink from written copy. Arrangement, form and proportion of letters, execution, etc., are a part of the problem.

*Class F.*—A problem which, in addition to technique, will reward a man for originality of solution and clear presentation.

### Judging

First, second, and third places may be awarded in each class. Honorable mentions, the number of which is left to the discretion of the judges, may be awarded.

Theory, practice, technique, and student judgment shall constitute the basis for judging the drawing.

The judges shall be six in number selected by the Chairman of the Division of Engineering Drawing, and shall be divided into two groups of three, each group to judge four or five classes of drawings only. The Chairman of the National Competition Committee shall be, ex-officio, a non-voting member of the judging committee.

### Comments

The National Drawing Competition Committee is as follows:

John H. Butler, New Mexico State College
J. Lawrence Hill, Jr., University of Rochester
Fridjoft Paulsen, San Mateo Junior College
Charles E. Rowe, University of Texas
Eliot F. Tozer, Northeastern University
Stanley G. Hall, University of Illinois, Chairman

Renewals of subscriptions to the *Journal of Engineering Drawing* are now due. The renewal price is one dollar. The Publications Committee requests prompt renewal so that the January issue may be mailed promptly. Send your renewal to R. R. Wosencroft, P. O. Box 2042, Madison, Wisconsin.

## BOOK REVIEWS

*Elementary Theory of Equations.* By WILLIAM VERNON LOVITT. xl, 237 pp. Prentice-Hall, Inc. New York: 1939. $2.50.

The recent appearance of several new text books on the theory of equations indicates a revival of interest in the exposition of this very important and very fascinating topic. For some time the reviewer has believed that such a course should be a *must* course in every under-graduate mathematical curriculum—this is because of its undeniable importance. What is the secret of its fascination? I believe that it lies in the composite nature of the subject; it is at one and the same time an algebraic, an analytic and a geometric adventure on a grander scale than the much more completely compartmented subjects that precede it. In the attack on its problems no holds are barred.

The present book is unique in two respects. First it presupposes no knowledge of the calculus, but introduces the essential ideas of that course as they are needed. For this reason the book may be used relatively early in the student's mathematical schedule, offering him at the right psychological moment the opportunity for a complete breaking away from mere formalism than did even his analytic geometry. Here is wide scope for strategical thinking. The second distinctive feature is an excellent discussion of Graeffe's method of solving numerical equations, a feature which the author justly claims belongs to no other book of its kind.

The discussions are clear and simple and well within the grasp of the precalculus student. Illustrations and problems are numerous and good. Many of the problems are new. Answers are appended at the end of the book. An adequate index is supplied. The publishers on their part have produced an attractive volume both in format and binding. The reviewer is confident that the appearance of this excellent text will help to stimulate undergraduate interest in an indispensable part of any mathematical education.

A. E. STANILAND

*Storehouse of Civilization.* By C. C. FURNAS.

This book was written primarily for teachers of science, but it is admirably adapted to a much wider audience. Its simple, lucid style, its nontechnical language, its skilful use of charts and diagrams make it readable by the intelligent layman. Moreover, de-

spite its simplicity, the engineer will find it worth reading. He will enjoy the story of the rapid increase in our production of fuels, goods, and services. He will be startled and perhaps distressed by convincing evidence that America has emerged from her adolescent period of rapid growth in population; that she now enters middle age, and must face the problems of adjustment to a relatively static order.

Most of the book consists of a description of the material resources of the United States and of the techniques of prospecting, mining, and manufacture. It gives a rapid survey of up-to-the-minute information as to the ferrous and non-ferrous minerals, synthetic ammonia, resins, rubber and textiles, and soils.

Particularly important is the section on energy which traces the development of the prime mover from the oxcart to the Diesel engine, discusses the probable exhaustion of our fuels, and the importance of government control to promote conservation.

Most significant is the last quarter of the book which discusses social impacts and implications. Professor Furnas, a chemical engineer, has served on national committees dealing with the effects of the machine on society. His words carry weight when he contends that idle factories and ever deeper depressions will continue to plague us until income is so distributed that the standard of living of the masses is raised. Our illness is not due to *over* production, but rather to *under* consumption.

This book, suitable in difficulty for use by the layman contains plenty of meat for the engineer.

OSWALD BLACKWOOD

*Technical Methods of Ore Analysis.* Eleventh Edition. By ARTHUR J. WEINIG AND WILLIAM P. SCHODER, based upon the text by the late Dr. A. H. Low. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, 1939. Price $3.75. 325 pages.

I cannot start this review better than by quoting from the preface of the book itself: "Technical Methods of Ore Analysis" by the late Dr. A. H. Low has been a standard reference book in mine, smelter, mill and student laboratories. The work has been revised in the present edition to bring the quantitative analysis of ores up to date.

"This revision retains with corrections all the original material of Dr. Low's work which is still valid. The important changes are (1) the uniform presentation of methods; (2) the introduction of recently established methods; and (3) the use of spot tests as an aid in analytical work."

The present reviewer is pleased to see this old friend again brought up to date in such an effective manner, and by such competent successors to the original author. The new edition gives the worker in analytical chemistry a confirmation of such of the old standard methods as are still valid, and along with that also new methods. A portion of the tenth edition giving instructions to students is omitted, also the portions dealing with boiler water, coal analyses, and oil testing; these omissions being in line with the title of the text. Aside from some six pages on apparatus required in the Introduction to the Semi-Micro Methods, very little space is occupied with illustrations or descriptions of apparatus. For most of the elements two or more methods are given.

There is in this eleventh edition first a new section on "Semi-Micro Methods," for qualitative testing. This should be a most useful innovation, especially with the two color plates that are included. Following this there are thirty chapters devoted to the analytical methods for the elements, in alphabetical order, including: Aluminum; Antimony; Arsenic; Barium; Beryllium; Bismuth; Cadmium; Calcium; Chlorine; Chromium; Cobalt; Copper; Fluorine; Iron; Lead; Magnesium; Manganese; Mercury; Molybdenum; Nickel; Phosphorus; Potassium and Sodium; Silicon; Sulfur; Tin; Titanium; Tungsten; Uranium; Vanadium; Zinc. Each chapter is headed with a brief one page table giving data of interest especially to the analytical chemist on the important minerals of the element treated in that chapter, a single element to the chapter, except for potassium and sodium together.

The methods of analysis are presented generally in a uniform fashion under the headings: "*A.* Application"; "*B.* Interfering Elements"; "*C.* Procedure"; and sometimes "*D.* Modifications"; or "*D.* Solutions Required." The instructions for working are given in clear, concise language, sufficient in general for the ordinary worker, but without superfluous verbiage.

Two final chapters, XXXII and XXXIII, on "Selective Analyses" and "Preparation and Standardization of Solutions"; Tables, of which the most important is one of "Chemical Factors" a brief Bibliography, and Author and Subject Indices conclude the text. The chapter on "Selective Analyses" deals mainly with estimating the forms of elements present in a sample, as oxide or sulfide, etc. The chapter on Solutions consolidates that information and saves both repetitiion and loss of time in search for it.

Messrs. Weinig and Schoder have done an excellent piece of work in this revision. And John Wiley & Sons, Inc. have done an excellent piece of book making in getting it out.

S. L. GOODALE

*Electrical Engineering Experiments.* By HENRY R. REED AND GEORGE F. CORCORAN. John Wiley & Sons. 500 pages. Price $2.75.

A survey of this book which is intended for the electrical engineering laboratory gives one a feeling of a work well done. In covering this wide subject the authors have brought experiments together which have wide acceptance and usage and have added new and interesting ones.

The book has print which is easy to read and it contains numerous diagrams and illustrations. The photographic illustrations are large enough and of such quality as to be of real value which is too often not the case in engineering papers. The authors have used well prepared oscillograms to illustrate the behavior of circuits and apparatus to good advantage.

Among some of the points which the reviewer feels deserve special mention are the experiments on magnetic circuits, electro magnetic induction, voltage regulation by the two reaction method, measurement of phase shift in synchronous motors and three phase connections using a single phase transformers.

The book is divided into 7 sections, as follows:

I. Fundamentals
II. Direct current machines
III. Alternating current circuits
IV. Transformers
V. Synchronous motors
VI. Induction machines
VII. Electronics

In addition the introduction contains a presentation of the common types of meters for measuring current, voltage, power, energy, speed, frequency and other quantitative values. The information presented for each experiment contains theory, laboratory exercises and typical results. There are altogether 130 experiments written for the 7 sections just enumerated. This would allow the individual user of the book a liberal choice so as to conform with equipment and topics which are emphasized at a particular laboratory. The book can be used by non-electrical engineering students as well as by electrical engineering students.

The reviewer believes that this text should fit the needs of many laboratories in presenting a broad fundamental training in the Electrical Laboratory.

R. W. AHLQUIST

*My 50 Years in Engineering—The Autobiography of a Human Engineer.* By EMBURY A. HITCHCOCK, in collaboration with MERRILL WEED. The Caxton Printers, Caldwell, Idaho. 277 pages. $3.00.

"Here is the story of an engineer whose working life has spanned the period of the most rapid development in science and engineering the world has ever seen. When Dean Hitchcock started work in his chosen profession, information and products which we now give scarcely a passing thought were either unknown or but laboratory curiosities. In 1890 when he began work it had been only about thirty years since the first oil well was drilled by Drake in Pennsylvania and thirteen years since a successful internal combustion engine was run and about ten years since a workable gasoline engine was introduced to the public. The steam engine was still the principal source of power to operate our railroads, ships, and factories. . . . In many of these outstanding developments, Dean Hitchcock has had a hand. Important as these contributions are, however, his most important work has been preparing young engineers to take their places in the world of industry. Many of his students have made large contributions in various fields of engineering and science."

The above is taken from the Introduction by Dr. Charles F. Kettering, himself one of Dean Hitchcock's students at Ohio State University.

In this most interesting book Dean Hitchcock takes the reader on a real voyage of adventure, beginning with his boyhood days in the 1870's in western New York, when he and his brothers experimented with various mechanical devices, and passing on through his years as a student in mechanical engineering at Cornell University where Dr. Robert Henry Thurston was then Director of Sibley College. Next we learn of a number of engineering jobs including a summer in a factory operated by John Edson Sweet and several years with the Corliss Engine Company.

Then followed some twenty years of teaching at Ohio State University, during which Dean Hitchcock had many interesting experiences outside the class room including the first heat-balance tests on locomotives in service, investigations of airbrakes in service, development of methods of measuring flow of natural gas, and a trip to an out-of-the-way section of Mexico to examine a coal mine.

From 1912 to 1919 Dean Hitchcock was engineer for a utility management company and much of his time was devoted to the development of power in the Tennessee Valley. This part of the book is particularly interesting because of what is now being attempted in the Tennessee Valley. Chapter XVII contains a discussion of Muscle Shoals and the T.V.A.

In 1919 Dean Hitchcock became vice president of the Bailey Meter Company of Cleveland, and one year later became Dean of the College of Engineering at Ohio State University, a position which he held until 1936 when he became Dean Emeritus. During his year with the Bailey Meter Company, Dean Hitchcock had many interesting experiences including the recruiting of engineering graduates for a training course inaugurated by the company, and the development of these young men in the training course.

As Dr. Kettering states in the Introduction, it was as Dean of Engineering at Ohio State University that Dean Hitchcock made his greatest contributions. The writer finds himself wishing that a larger part of the book might have been devoted to that portion of his career, but not by omitting anything else that is now included.

This book is important not only because of its subject matter but also because it is written in a way that should make it an inspiration to all engineers who read it, both young and old. Certainly it deserves the attention of all those who in any capacity whatever are concerned with engineering education.

PAUL T. NORTON, JR.

# SUMMARY OF "PRESENT STATUS AND TRENDS OF ENGINEERING EDUCATION IN THE UNITED STATES" PREPARED BY DUGALD C. JACKSON

By CHARLES F. SCOTT

The Committee on Engineering Schools of the Engineers' Council for Professional Development recognized that the comprehensive data it acquired from 1935 to 1938 in surveying 679 curricula in 136 institutions in its accrediting procedures afforded exceptional opportunity for an analysis of the current status and trends in engineering education to supplement previous investigations. It secured $10,000 from the Carnegie Foundation and the services of D. C. Jackson to direct the study.

Professor Jackson's report has just been issued. A request for a review of it raised the question of how best to summarize a report which is itself a summary. The present reviewer recalled his own experience in reading the report and took it as the basis in deciding how to proceed.

One soon finds on perusing the pamphlet report of 180 pages that he would miss much that is interesting and important if he relied wholly upon the general title or the meagre titles in the Table of Contents. There is a wealth of material to which they give no inkling or suggestion. One must read patiently and persistently as there are but few topical or typographical guides. Possibly a helpful type of review will be a listing of some of the notable material which the report contains.

In the *Introduction* (Chapter I), Section A, is an historical summary indicating the logical sequences in engineering education beginning with Rensselaer in 1824; the Land Grant Act of 1862; the formation of the S. P. E. E. in 1893; its initiation in 1907 (proposed by Dr. Jackson, then its president) of a joint committee of the engineering societies which culminated in the Mann Report in 1918; the S. P. E. E. investigation of 1923–29; E. C. P. D.—stimulated by what had gone before—in 1932. This notable story is a personal account by one at the forefront since 1907.

Section B presents definitions—by words and by ideas—of engineering and the profession. Section C contrasts differences between engineering and other professions and their bearing on education.

In *Status of Engineering Education in America, 1939* (Chapter II), there is much of historical interest beginning with engineers

who were graduates of the U. S. Military Academy (organized in 1802); the sequence in establishing schools for the various professional branches; "response to growing national needs"; value of "a good engineering education with a sound philosophy"; relations of engineering education to research much more favorable than to political economy; pedagogical and scientific vs. practical aspects in former years; influence of S. P. E. E.; majority of present schools "are now in sound status and are wide-awake to improve their effectiveness"; principal faculty defects are (1) lack of recognition of unity of learning in science and in political economy as applied to engineering; (2) inadequate espousal of professional ideals; (3) failure to impress idea that engineer's life demands continuous study; (4) failure to dovetail the curricula into political economy (as into science); (5) failure to utilize research in all levels of education; fallacy of proposals to make educational changes by state law in interest of certain groups; influence of S. P. E. E. (Wickenden) Report of investigation in stirring action on pedagogical problems; engineering graduates as employees in construction and in industry; teaching and research activities of moment to the nation—creating new attitude in teachers and students; common interest in "enrichment of engineering education"; individualistic characteristics of schools; statistics on enrolment—present and past.

*Causal Conditions Supporting Recent Accrediting Enquiry* (Chap. III) gives in Section A a discriminating summarization of three reports. "Certain definite inferences and recommendations" of the Mann Report (The Carnegie Foundation for the Advancement of Teaching, Bulletin No. 11 of 1918) are well presented in half a dozen pages. Then follows a condensed epitome of about equal length of the "more extensive and equally more elaborate" S. P. E. E. (Wickenden) Report; a Report by Dean A. A. Potter on Engineering Education (Survey of Land Grant Colleges and Universities, Office of Education, Bulletin No. 9, 1930, I, 789) in a project initiated through the Association of Land Grant Colleges and Universities and carried out in 1927–29 by the U. S. Office of Education, receives a four-page review.

In Section B, the consequence of the three foregoing reports and other publications is found to be a general attitude which led to a Conference on Certification by the engineering societies which eventuated in E. C. P. D. Its objectives and organization are presented on eight pages.

Thus the "Causal Conditions" contain a 24-page factual and philosophical review of major movements in engineering education during the past third of a century.

*Committee on Engineering Schools and Its Procedures* (Chapter

IV) quotes and amplifies the "Basis for Accrediting" as published by E. C. P. D. in its annual reports and accompanying its accredited lists; gives statistics of accrediting; discusses man-qualities of the faculty vs. physical plant, and other "less tangible aspects."

*Procedure in Relation to Coöperative Courses and Evening Curricula* (Chapter V) is informative. In a dozen years the institutions giving degrees for evening work have increased by one-half and the students (3500 in 1924–25) have about doubled. The tentative attitude in accrediting is commended.

*Comments on Progress of Committee on Engineering Schools* (Chapter VI) deals largely with the policy as to curricula other than the six major ones. Regarding them is this sentence: "Some two hundred and fifty such adverse reasons are recorded relating to the curriculum concerned, the teaching staff, the physical facilities, the institution in general, the administration, the standards and quality of work, the library." (Seventeen different curricula are accredited.)

*Tables and Charts* (Chapter VII) presents in 13 tables and 22 charts distributed through 60 pages of text the new data acquired in the accrediting procedure. On the eighth page of the chapter are listed five groups of factual features digested from the questionnaires as follows: 1, distribution or classification of schools; 2, financial features; 3, ratios bearing on quality of instruction; 4, qualifications of faculties; 5, subject groups in curricula. An intimate view of the new data, gained from reading titles or text, indicates the following items.

Significant classifications are made; the institutions are subdivided as to number of curricula accredited (high, medium, nul); as to geographical location; as to types of support (1, endowed, 2, state, and 3, municipal universities; 4, endowed and 5, state polytechnical institutes; 6, state, 7, endowed, and 8, military colleges). Data (usually presented under each of the several subdivisions) are given as to salaries of faculty members of various rank (5 charts); instruction cost indices; incomes and values of facilities reduced to per student basis; ratios of laboratory areas and students; ratios of students and instructors; highest degrees held by faculty members; inbreeding of faculty; total teaching experience of faculty members; distinction of faculty members measured by listings in biographical directories and by membership in professional societies (table shows that of the full professors teaching engineering subjects 43 per cent do not hold membership of high grade in an engineering society and that 36 per cent are not members of S. P. E. E.); curricula requirements for graduation in different branches; evolutionary trends in the different curricula. The trends are shown in an extension to 1934 of the chronological charts (1870 to

1923) in the S. P. E. E. report which show the amount of time allotted to each subject. Changes are slight; there is a minor reduction in the main branch of engineering and in mechanics and hydraulics with increase in "other engineering" and electives; foreign language has disappeared and there is slight increase in economics and social sciences.

The text makes the following comment: "curricular distribution of subjects is not determinative between accrediting and non-accrediting . . . there are more divergences between accredited curricula or among themselves than between some of them and some of the curricula which failed to be accredited. This again reflects strong light on the importance of qualities of faculties and of administrative attitudes."

In the text are presentations and discussion of many items (usually classified with reference to the high, medium and nul number of accredited curricula), such as training, experience, morale and attitude of teaching staffs; teaching loads; curricula in terms of standards of instruction, course balance and course content; scholastic work of students (which "shows the same sinking situation in the nul category"); quantity and quality of research; libraries; service departments—English, history, mathematics, physics, chemistry, economics, and in some cases mechanics and drawing; physical facilities ("institutions of the nul category are extending their efforts over fields for which they are not financially competent"); assignment of responsibility and authority.

This sketchy review recounts the subject matter and the method but is by no means an adequate summary of the findings of the report. An enormous amount of data has been digested, epitomized, ingeniously classified, painstakingly presented and then interpreted by a competent commentator. It is a hand-book of information, stimulation and inspiration for the young engineering teacher.

*Present Trends in Engineering Education* (Chapter VIII)—the epitome of the report—has 21 numbered sections covering 19 pages. Happily Dr. Jackson has made it unnecessary to attempt to summarize his conclusions here as his own ten page digest of this chapter appears in our JOURNAL OF ENGINEERING EDUCATION, October 1939, p. 138.

It may be serviceable, however, to bring together the phrases which the painstaking reader may underline as the keynotes of the several sub-chapters.

1. Engineering education is, in general, improving in its adaptation to its purposes and its observed defects are being remedied.

2. The educational attitudes of faculties have changed during a decade toward individual self reliance and resourcefulness of the student and other matters.

3. Two trends; improved pedagogical methods with more responsibility on individual students for self-education; research for students in upper undergraduate years. These accord with the Carnegie Foundation Bulletin No. 29 (1938) on *The Student and His Knowledge.*

4. Outstanding influence of some schools is related to discrimination in selection of staff appointees and resulting repute of teachers.

5. Recognition that "the intelligent interest which the individual brings to bear upon a given subject" outweighs the amount of time spent in formalized class exercises.

6. Increased care in selecting freshmen; examinations of comprehensive character; distinction of faculty members attracts selected students.

7. Increasing interest in student activities sponsored by national societies—student conventions and prize papers.

8. Softening of departmental borderlines; experimental curricula for developing new aspects of engineering.

9. Attention to social relations and responsibilities—touches engineering education on all sides. Relations of S. P. E. E. to E. C. P. D. and to industry and swing from empiricism to sound science.

10. Change in teaching of English almost revolutionary. Better grasp on mathematics and sciences.

11. Tremendously changed emphasis on interrelations between engineering and political economy (economics and sociology).

12. Forward and upward trend of junior colleges.

13. Curricula studies reveal distinct trends, also erratic variations. Changing proportion of subjects, changing pedagogical methods, formulation of specific curricula. Trend toward arts of expression. Proposals to lengthen. Sound graduate work increasing.

14. Tendency toward common instruction preliminary to division into various curricula calls for definitions of the fundamentals of science and political economy.

15. Advances in the practice of engineering and in industry bring demands for changes in education. Among results are evening curricula and coöperative courses.

16. Dynamic changes throughout engineering call for formulation of a broad but convincing definition of the purposes of engineering education.

17. Research for upper classmen and graduate students may lead to concentration of advanced work in suitably equipped institutions and for institutional coöperation.

18. Recognition of the professional character of engineering education by smaller colleges has been promoted by the E. C. P. D.

program. Public recognition of intellectual qualities required for engineering achievement.

19. Securing right kind of teachers is a lagging factor.

20. Reasonable retirement and pension policies desirable. Competent education demands intimate interrelation of teaching, research and practice.

21. Softening of institutional jealousies promotes coöperation. May reduce present duplications and overlapping. Shift of technical institutes to engineering colleges causing unbalance. Development of strong institutes for training technicians for industry much needed.

*Conclusion* (Chapter IX) gives particulars regarding the compilation of the report. The *Appendices* give a "History of the Committee on Engineering Schools and a Digest of its Minutes"—enlightening as to policies and procedures; also a "Facsimile of the Original Questionnaire used by the Committee."

An extended review of the "Jackson" report under the title "By-Products of E. C. P. D." appears in *Mechanical Engineering* for December 1939. It was written by the Editor, George A. Stetson, former member of the S. P. E. E. Council. His concluding paragraph may fittingly conclude also the present summary:

"These fragmentary portions of a comprehensive and penetrating survey of trends do small justice to Dr. Jackson's report. If they have aroused in the reader a desire to study the entire report, which may be purchased from E. C. P. D., they will have served their purpose."

## CHANGE IN NAME OF THE AMERICAN PHYSICS TEACHER

*American Journal of Physics* is the new title of the bi-monthly publication known since its inception in 1933 as "The American Physics Teacher," according to an action taken recently by the American Association of Physics Teachers concerning its official journal. Remaining under the editorship of Professor Duane Roller, of Hunter College, and under the publication management of the American Institute of Physics, the journal will continue to stress the educational, historical, socio-economic and philosophic aspects of physics, and the instruction of students who take physics as part of a liberal education as well as those who specialize in the science.